SCIENCE

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SOME PROBLEMS OF MEDICAL EDUCATION[1]

THE education of medical students has been a subject of perennial interest to both teachers and practitioners for a long time, and although great advances have been made, there is still general dissatisfaction with the results as shown by examination tests and the ability of recent graduates to meet the emergencies or even ordinary duties of professional work.

At the meetings of the council on medical education of the American Medical Association, the confederation of examining boards of the United States and our own association, the faults in preliminary education, in professional training, and the needs of still greater clinical opportunities, have been pointed out and are familiar to you all. Out of all these discussions, two general educational remedies have been advocated.

1. That one or two years of college work, which shall include one year of chemistry, physics and biology, be added to the preliminary training.

2. That a hospital or clinical year be added, making the medical course, as measured by the standards of England and Germany, six years.

In these two propositions certain questions arise which concern this association especially. For us the questions are not merely academic, but questions of administration, standards and pedagogics.

The house of delegates of the American Medical Association at its recent meeting

[1] Presidential address, delivered before the Association of American Medical Colleges at Chicago, February 26, 1913.

decreed that for a medical college to be put in the highest rank, the requirement of one year of college work, including instruction in chemistry, physics and biology, is necessary. This has focused attention on this proposition and many colleges will feel compelled to require it.

In discussing this proposition, the first question that arises is: How is the student to obtain this year's work in the designated sciences?

In states with state colleges or universities, the question has been answered. The high school and university courses are so correlated that with a minimum amount of disturbance the student passes from one to the other. The financial aspect is not a burdensome one, as the fees in the state-supported institutions are relatively small. But in the greater part of the country no such coordination exists, the colleges and universities are disassociated from the high schools, so that there is a greater or less impediment to students passing from the high school to the colleges, as they are not accepted on their high-school credentials. In some, the students are admitted only on examination in addition to their credentials, and others demand special preparation in subjects not included in the high-school course. Universities and colleges should feel it their duty to correlate their entrance requirements with the high-school courses of their locality.

In this connection another obstacle is met with in localities where the universities and colleges are not part of the general educational system, *i. e.*, the attitude of these institutions toward one- or two-year students who are taking the course to meet the medical school requirements. It does not, however, apply to universities with medical schools. The universities frankly admit that they do not want these students, and when we discuss the requirements as related to sciences and languages with them, they say: "Why should we modify our curriculum to meet the needs of these one- or two-year students? We are not conducting this college as a preparatory school for technical or professional education." And the head of one of the largest universities in the east with no professional school attached, said: "If I find men coming here to meet this requirement, I will change the course so that they can not get the science branches demanded in less than three years."

To meet this requirement, must the course be taken only in an institution having the right to grant the B.A. or B.S. degree? Should the requirement read: "One year's work of college standard, which year must include instruction in chemistry, physics and biology. This year must be in addition to the high-school course"?

This raises at once the most important question of equivalents and all the dangers of evasion. It has been suggested that these courses might be given in technical high schools which only admit students after the completion of a high-school course, and in support of the suggestion, it has been claimed that such a course would be much more definite than that given in many literary colleges, and it would be under the supervision of the educational department of the state. Many deny the right of high schools to do the work of the colleges, and, in addition, urge that it is not meeting the spirit of the requirement.

This raises the next question. What is the object of this added year of preparation?

In general terms, the answer is: "Power to grasp professional subjects."

Is this power gained best by increase in general education in the so-called "humanistic" or "culture" courses, or by tech-

nical training in the sciences? The view point of the institution in which the instruction is taken will determine the character of the course. In institutions with medical schools, the course will be correlated to the future needs of the student. In colleges without such affiliation, these courses will be part of the general college régime which deals with education so as to insure a wide and general character to the subjects it embraces, whereas it is imperative for the future use of such studies, whether in engineering or medicine, under the pressure of modern life, that the student should be equipped with the necessary knowledge in the shortest possible time that is compatible with thoroughness. From a practical point of view, generalities must be abandoned and definite limits set. Are the undergraduate college teachers willing to do this, or will they insist on generalities?

This raises the question of the cultural value of the liberal courses as opposed to the so-called science or technical subjects. All agree that "the preparatory training for life should be liberal and humanizing; that the course of study in the college, in addition to having a broadening influence, should also inculcate in the student some specific kind of mental training which will fit him better to take a high rank in whatever career he may happen to select." As students enter the college to later select medicine, the studies should by scope, content and method give him the specific kind of mental training that will better fit him for his life work.

While valid objection might be raised against introducing into the college course professional instruction, as defined by Karl Pearson, *i. e.*, "training in the art of a specific profession," this does not hold against technical education in the underlying subjects of a profession, and for the medical profession these subjects are the natural sciences, chemistry, physics and biology being specified as those most helpful.

It has been said that these subjects are lacking in educational value from the standpoint of "general training"; that they do not provide mental training for the man who has no intention of entering a profession. The answer to this objection is that the fault is not in the subjects, but in the manner in which they are taught, and also in the content of the course. President Hill, of the University of Missouri, has emphasized the value of motive in acquiring knowledge and gaining insight into a subject. "Insight normally brings culture, especially in human life, and vocational motive not only does not interfere with, but tends to foster, the development of a deeper and truer insight into the significance of scientific knowledge."

Can a knowledge of chemistry, physics and biology be acquired in one year of college work with sufficient fulness to be of value to the student in his medical course? There are two opinions on this question: one, that a single year is inadequate; that these subjects should be taught as pure sciences and on general lines with no regard to future use; that in one year the student will have only a verbal acquaintance with things that he does not understand. Those who hold this opinion are urging the two-year course, not so much as a preparation for medicine as for the general cultural value. They would have not more than a single year's work in each of the science branches and more of the general college subjects added.

The other opinion is that one year is a sufficient time in which to gain a familiarity with the *principles* of those subjects which have a bearing on medical sciences.

This is a very different thing from teaching them as medical subjects. It would set definite limits on the course and not try to cover the entire science in a single year. In chemistry the general basic principles underlying the science rather than isolated facts should be taught, and these principles can be learned just as well by studying substances and processes in the laboratory which have a distinct bearing on medicine, rather than on metallurgy or mineralogy. Probably the college course in chemistry is the best standardized of all.

In physics, the student needs a fairly wide knowledge so far as it can be gained without higher mathematical processes. Laboratory instruction should form a large part of it. The important topics are specific gravity or relative density (there should be real understanding of what these terms mean), osmotic pressure and diffusion, hydrostatics, acoustics and its common application to sound, pitch, resonance, optics, laws of refraction and reflection, as applied to mirrors and lenses. Heat; the thermometer, laws of specific heat, cryoscopy, calorimetry and the relation of heat to work. Electricity; the elements of static electricity and of galvanic and foradic currents. In mechanics, the statical aspects only. Much of the dynamics usually taught should be omitted, also the study of absolute temperatures, absolute units. The object of the course in physics is that

> the student may gain a comprehensive and connected view of the most important facts and laws of elementary physics. There is need of limiting the course in physics, because the courses in universities and colleges are more adapted to train professional physicists than future practitioners of medicine. The two need a different training. A study of the curricula at many colleges shows that in one single year an elementary course requiring very little mathematics is followed by a highly specialized mathematical course, having practically no reference to the experiences of life.

In the biological course, it is important that the student should become conscious of the characteristics of living things. Without some general biological training, it would be impossible for him to give to his medical physics and chemistry a biological application. By dissection of a few of the lower types, by witnessing a few simple physiological experiments on plants or animals, by examination of simple tissues under the microscope, he should obtain an idea of the correlation between structure and function, the general build of the elementary tissues; and the process of digestion, respiration, assimilation and reproduction, which together make up our conception of a living organism. A comprehensive view of the subject, but well within the power of the student to understand, is rarely given. On the other hand, a great deal of useless information is given and much precious time and energy is wasted on botany, zoology and highly specialized courses.

By such courses, beyond the accumulation of facts in the different sciences which the student may obtain, he should have become an accurate observer, been interested in the art of inquiry, have acquired a fair degree of manual dexterity and use of laboratory instruments, have cultivated proper habits of study and work—in fact, trained for efficient professional study. His mental horizon should be extended, a new attitude of mind toward his work fostered; his reasoning faculties should be developed so that the insistent "*why?*" compels him to seek the answer. To give this training demands that the subjects are taught in an intensive manner, that interest is aroused, that the student feels that the subjects are important, not only as sciences, but for their future professional application. Unfortunately, the generalities

of the college courses do not often give this direction.

It must be borne in mind that it is possible to educate a student away from scientific thought, as well as toward it. It has been disappointing to note the effect of a general college education on medical students. They come to the medical school often unwilling to adjust themselves to the régime. They have lost much of their receptiveness, they are to a degree mentally arrogant, they have a pseudo-philosophical and not a scientific frame of mind. It is for this reason that often the high-school graduate gets more out of the course than the man with a B.A. degree.

In demanding one year of college work as an entrance requirement, the medical schools have not only a right, but a duty, to demand of the colleges that the course be standardized; that it be made worth the students' time, both in content and methods. Otherwise it is useless, both from the cultural and technical standpoint. It will be not a specific, but a quack remedy, prescribed for the cure of our educational illness. I firmly believe in better preliminary education of the medical student, and am only raising these questions that they may be discussed.

What influence will the added year of preliminary training have on the medical course? Will it allow of changes in our present curriculum? For it is conceded that at present it is overcrowded; that the difficulties of medical education are increasing; that the burden is heavy on both teachers and student; that there is a waste of effort that is almost tragic.

The problems of medical education are bound up with the progress in medicine and therefore can not be solved once and for all, but must be constantly under consideration and adjustment. In all consideration of them, certain facts must be kept constantly in mind. The period of study can not be indefinitely extended. There must be a proper proportion between the period of preparation for and practising of a profession. As Professor Starling has so well put it, "The brain of man does not increase in capacity or in power of assimilation with the growth of science." "How is the necessary limited time of medical education to be most profitably employed in imparting to the student such knowledge as is most useful to him in his future career?" The effect of the overloaded curriculum on the student is most harmful. He gets a smattering of many things, instead of a thorough grounding in principles. He forms faulty mental habits, early becomes surfeited and loses interest in the work; everything is gauged by examination value; he has no sense of proportion, small details and facts loom large, basic principles are unimportant. At what point should the unloading begin? What ballast should be thrown overboard?

Notwithstanding the work of the committee on curriculum of this association and that of the council on medical education of the American Medical Association, the usual medical course still contains much useless ballast, some of it traditional, some of it due to demands of state board examinations and some gradual "accretion" due to a desire to meet the advances in medical sciences.

Professor Welch, in opening the discussion on "The Medical Curriculum" at the meeting of this association at Baltimore, said:

> One of the fundamental things is to inquire, What is the object of medical education? To make good doctors; there is no question that that should be the underlying conception in our schemes for medical education, and unless you can define a given course as bearing on that training, it has no place in the medical curriculum. If the training in physiology can not be shown to be to make good doctors, it is

not defensible. The same can be said of pathology, or any other subject in the curriculum. The ultimate aim of medical education is to make good practitioners of medicine. Another thing that confronts us at the start of any consideration of the medical curriculum is: What kind and what amount of knowledge can the student acquire during the four years of his medical education? The most you expect is to give to the student a fair knowledge of the principles of the fundamental subjects in medicine, and the power to use the instruments and methods of his profession; the right attitude toward his patients and toward his fellow members in the profession; above all, to put him in the position to carry on his education, because his education is only begun in the medical school. The student does not go out a trained practitioner, a trained pathologist, or a trained anatomist or a surgeon.

President Pritchett in the introduction to the "Bulletin on Medical Education in Europe" says:

Even if one may assume that students enter the study of medicine properly trained in the fundamental sciences, the problem of the curriculum is a serious one. The report shows a general tendency toward overburdening. The question naturally arises, What ought the course of study of a technical or professional school to accomplish? The medical school can not turn out finished doctors. It can not teach all that it is important for the practitioner to know. Under these circumstances it does best to accept frankly certain limitations, and so to train its students that they will be disposed subsequently to remedy their own deficiencies. Inclination of this kind appears most likely to result from a training that prescribes only the indispensable minimum, requiring in addition more thorough performance in a few directions and leaving opportunity for still further effort to those of greater energy, interest or ability.

Is not some of the overload due to our having ignored the above facts, because we have tried to teach all the sciences and all the art and science of medicine, to turn out specialists in medical sciences, in research work, and in medicine and surgery.

The past decade has seen a most marvelous improvement in the teaching of medical sciences and opportunities for laboratory work. Gone, never to return, are the purely professional courses in anatomy, chemistry and physiology, given by busy practitioners or recent graduates, whose knowledge of the subject was but little in advance of the students, and who were able to repeat a few simple experiments. To-day the laboratory courses in the medical sciences are far more extensive than even the German schools. In this country the laboratory courses are paramount and the lecture courses subordinate; in Germany it is the reverse. The development of these courses has been so rapid that the necessity for setting limitation on them has not been observed. President Pritchett says:

The medical curriculum, extended as it is in Europe, over five years, has reached the limits of its capacity; it can contain no more. Exactly the same process has occurred in medicine as has taken place in the training of engineers. In fact, experience in these two kinds of technical education during the last fifty years has been strikingly similar. Most naturally the medical school and the engineering school have endeavored to include in their teaching some knowledge of the new sciences developed in the last half century and of their application. As a result, the burden devolved upon students of medicine and of engineering has grown enormously. The respective curricula have been formed almost altogether by accretion, something being put in, little or nothing taken out. As a result, both the medical student and the engineering student are called upon to carry, not only a heavier load, but a load made up of more parts.

As students come to the medical schools with better preparation in the sciences, there is a tendency to add more and more detail; to extend the laboratory courses and insist on all the precision, the rigor and the abstraction of the research laboratory; to teach the subjects as pure science and not as applied; to lose sight of the ability of the student; to go beyond the need of the future practitioners of medicine, and plan the course as if all were to be

chemists, physiologists, pathologists or research workers. The whole body of students should not be compelled to spend a disproportionate amount of time and energy upon topics which will be of use to a few only. Opportunity should be given to those who wish to pursue any subject beyond that given as part of the general instruction, but unfortunately our rigid curriculum prevents it. The student's time is too fully occupied to allow of electives or to take extra work in subjects in which he is interested, without neglecting obligatory courses. It has been well said that our system is a "lock-step" one.

The student should be so instructed in the fundamental principles of the science subjects that after graduation he may keep pace intelligently and be able to utilize further discoveries of these sciences as applied to scientific medicine. Beyond this we can not go.

In our attempt to make our student scientific we are defeating our object by insisting on too great detail, before he can understand the principles. The teaching of a subject as a pure science, without application to clinical subjects, causes him to have no motive or interest in it and to throw it overboard as soon as examinations are past.

While all agree that the inductive method is the proper one, when pushed to the extreme the method breaks down. This is a woeful waste of the students' time in the "work it out for themselves" method of some teachers.

The statement is frequently made that students do not carry with them beyond the examination period that general knowledge of anatomy, chemistry, physiology and pathology which should be a lifelong possession.

The reason that the students do not have a better grasp on the science subjects is because medical education has become less homogeneous. Under the old system, the primary or science subjects were taken at the same time that the clinical ones were. The student thus gained an inkling of the relation of his science subjects to his clinical work. At the present time, this relation is not apparent to the student unless it is pointed out to him. The science years are becoming more and more divorced from the clinical, and the fact should be recognized and the tendency corrected.

From my study of the methods of instruction given in many of the medical schools, I believe that teachers of the science branches are largely to blame for this. That the science subjects should be taught by specialists is conceded by all, and they are rightly in charge of the years devoted to their subjects. They have had a hard fight to gain recognition and are hostile toward any movement to introduce into these years any clinical work, and many have gone so far as to insist that it is not their function to give any definite application to the subject. This has made necessary the introduction of applied courses in the different subjects to bridge the gap between the science and clinical years. Too often these courses when given have to be taught by teachers not connected with the science subjects. The science teachers, especially if engrossed in research work, are too apt to teach only the more scientifically interesting features and consider that they have done their duty when they have given the lecture courses of their subject, and leave to their assistants the more important laboratory instruction. The majority of these giving the laboratory courses are young and inexperienced teachers who have not had the advantage of a medical training, and their

only knowledge of the subject is that obtained in the pure science courses. If any question of application arises, they are unable to answer it and therefore discourage all such inquiries or resent them as "catch questions."

Teachers in the science branches should be in thorough sympathy with the future professional work of the students, and I am of the opinion that teachers in medical schools should have taken a complete medical course as part of their training. There are many eminent teachers in medical schools who have not had this training, but they have been long in contact with medical institutions and have a saving sympathy with the clinical side. In the large university schools and where the school is divided, there is danger in this lack of sympathy with clinical work, which attitude the science teachers are only too ready to criticize harshly in the clinical man if he does not show sufficient interest in their particular science.

Medical progress is being retarded by lack of coordination of science and clinical departments. The lack of training in clinical medicine too often prevents the science teacher from being of assistance to the clinician. Medical and surgical methods do not always fit in with laboratory technique. The complexity of the problem causes him to give little scientific value to the investigations not made in a laboratory. It is this attitude of the science teacher toward the introduction of clinical work or clinical methods in the first two years of the course, that is causing not only the student to fail to appreciate the value of and becoming interested in the subjects, but also to make him less able to apply the knowledge that he has gained of laboratory technique to his work in the clinic and wards. His *work* in the laboratory has been on frogs and the lower animals only. When he comes to his clinical years he finds that he can not use the apparatus with which he has become familiar to human beings. He finds new factors enter into the experiment which confuse his previously formed conceptions; he can not interpret his findings. The science teacher claims that this applied instruction should be given by the clinical teachers and also says that they should be competent to do it, which latter contention we grant, but what are the two years of instruction in the laboratories for but to prepare the student for his clinical work? Wherever possible methods and apparatus should be employed that can be used in clinical investigations. The burden of this instruction should not be thrown on the clinical years, already so overcrowded as to make a hospital year a necessity.

To insure a better correlation between science branches and clinical years and allow of unloading, the hard and fast lines that are tending to separate the second and third year of the course should be obliterated. As students come better prepared in the underlying sciences and are able to accomplish more in the same time, instead of extending the courses in pure science, correlated clinical laboratory courses should be introduced in the second year.

If the teaching staff of the science branches can not give these courses, then clinical teachers, most likely young men who have been trained in laboratory method, should give them. This would be the best introduction possible for the clinical subjects, and students so prepared could more rapidly advance in the third year. It would permit of omitting much of the lecture course in this year and allow an early contact with clinical material. To obtain such readjustment hearty coopera-

tion is needed from science and clinical teachers.

The establishment of state board examinations has been of great aid to medical education. It has raised the general standards of the profession, and secured a more uniform curriculum over the entire country. It has, however, had a decided influence on the overloading of the curriculum, as they have yoked the old methods with the new. The necessity for arranging the examinations to meet the training of graduates of years ago, as well as the recent, has been detrimental to progress and has encouraged cram-quiz book methods and put a premium on ability to answer questions, calling for mere detail information of the subjects. The time has come when state boards of examiners should recognize the changes that have occurred in methods of medical education; that the student who is best educated has not the best knowledge of small and unessential details; that to meet the requirements of the state boards he has to have recourse to quiz compends for much that is of no practical use to him. The new methods have been in force long enough to establish a class by itself and for licensing there should be one type for the graduate of former days and one for the more recent. As at present conducted, both in content and method, it is satisfactory to neither class. This association, by the cooperation of the Federation of State Medical Boards, could be of great value in correcting this defect. The state boards are appreciating this defect as well as medical educators, and would welcome any plan which would allow of a practical examination, both laboratory and clinical.

The difficulty in arranging such an examination is the lack of money and laboratory and clinical facilities. States with centers of medical education could easily get the facilities by holding the examinations in those places and using the college laboratories and clinics and hospitals. Different dates could be arranged for various sections. The states should consider that it is their duty to provide the necessary funds. That such a plan is feasible is shown by the ease with which large numbers of candidates for the positions of hospital interne are examined, both by written and practical examination.

Examinations have, and probably will be, the means of testing the character of instruction given by the medical schools and the knowledge of the students, but they should be adapted to give a true index. They must coordinate with the methods of instruction. At the present time they do not. Rating colleges according to the ability of students to pass these examinations is putting a premium on only such instruction as will enable the student to successfully meet the test. It is exalting narrow training over broad education. Evaluating bodies should not place too much value on the percentage of failures and passing as an index of instruction in the colleges.

From members of the general profession one constantly hears the harsh criticism that recent graduates are deficient in detailed knowledge of this or that specialty. That while skilled in laboratory methods of diagnosis, they have acquired little of the art of medicine. They insist that many new topics ought to be added to the course of study.

Much of the overburdening of the clinical years has been due to adding topics or extending courses in the special branches to meet these criticisms. The profession as a whole should appreciate that the student must, in his college course, gain his training in scientific methods if he is ever to have it. That only the essentials can be

taught thoroughly. Faulty training in the essentials is caused by trying to do too much. That only so much of the special branches can be given as to make them safe practitioners, not immature specialists.

It is desirable that every practitioner should know many things about his relation to society at large, to allied professions and their problems, to organize charities and their activities, and the business methods of his own profession. However, these topics should not be introduced into the medical curriculum, they are part of the postgraduate education, which every physician should feel it his duty to acquire.

The need of unloading and correlation is a most pressing one, and it is our duty as an association of medical colleges to point that way.

The complex question of a hospital or clinical year has been under discussion for some time by this and other associations. That the student needs more extended clinical experience before beginning the practise of his profession is conceded by all. There is not the same unanimity of opinion as to the advisability of making a clinical year obligatory or whether it should be demanded by the colleges for the degree of M.D. or by the states as a requirement for the right to practise.

Before a decision can be reached many administrative and pedagogic questions must be answered. As the necessary data have not been gathered, this association should cooperate with other bodies in making a collective investigation of the subject. As a large percentage of medical graduates now voluntarily take one or more years of hospital interneship I believe the first step should be to give both academic and legal recognition to this postgraduate training.

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THE PSYCHIATRIC CLINIC AND THE COMMUNITY[1]

The increasing interest shown in the study of human activities is one of the most significant and hopeful signs of our times. Momentous as was the impulse given to science by Copernicus, Galileo and Newton one result of their investigations was to direct attention to a universe in which human beings were considered to be merely passive observers of natural phenomena. So absorbed did man become in formulating hypotheses to explain a theoretical universe of which he did not form a part, and in delving into the records of his own past history, he neglected the study of present activities. At last the course of events warned him that the lessons of remembrance or the hypertrophied historical sense had become "a malady from which men suffer."

The dedication of a psychiatric clinic is an event of more than ordinary importance to a community, as it marks the awakening of intelligent interest in man, as an active thinking being. Having striven for centuries to improve the methods for recording his fanaticisms, superstitions, sins of omission and of commission, and failures to adjust life to meet new conditions, he has begun at last to take rational measures to improve his lot, and to acquaint himself with the laws on which the social organism rests. As the value of this benefaction to the community will depend directly upon the intelligent use of resources and energy made available for rendering more effective service to humanity, may we not profitably devote a few moments in attempting to formulate some of the problems to the solution of which this clinic is dedicated. Errors in judgment committed now, in

[1] Address delivered at the opening exercises of the Henry Phipps Psychiatric Clinic, The Johns Hopkins Hospital, Baltimore, Md., April 16, 1913.

estimating the scope and the character of the investigations to be carried on in this building, might defeat the efforts of those upon whom the responsibility of equalizing opportunity and achievement must fall.

This clinic, in a peculiarly distinctive manner, typifies the human as well as the humane spirit of the twentieth century. During the seventeenth and eighteenth centuries the physical sciences had succeeded in breaking away from the traditions and superstitions which had hampered their development. Astronomy had been divorced from astrology, chemistry from alchemy, and the foundations of geology had actually been laid. In the nineteenth century the renaissance of the biological sciences was accompanied by the formulation and expression of a rational idea of man's position in cosmos. Towards the close of the eighteenth and the beginning of the nineteenth century a few investigators had already called attention to the importance of studying the activities of human beings; but not until the second half of the last century was there any realization of the fact that the most interesting phenomena of the universe for human beings to study were their own activities. How do we live, move and have our being?

To the lay mind the term psychiatry often suggests a very limited field in medical science, but those who take an active part in the work of this clinic will easily appreciate that they are engaged in attempting to find the solution of problems of far greater importance than any relating merely to the care of patients suffering from mental or nervous disorder. Anomalies of thought and conduct are studied in order that the knowledge acquired may be applied directly to making life for the majority of persons pleasanter and more effective. Institutions of this character are intended primarily for the study of human nature along broad biological lines.

We are justified in considering disease as an analytical process which reduces to a comprehensive form the complex activities we designate collectively as health. An intimate knowledge of abnormal states of mind and body is, as Pinel affirmed, a key that unlocks the secrets of human history. By making use of nature's contrast of functions we may also gain an insight into that continuous process of adjustment we call life. From the study of disease the facts have been gathered for the foundations upon which modern preventive medicine has been established, and through it a new meaning has been given to life and greater efficiency in thought and action to those who profit by the lessons of science. For centuries the different parts of the body have been studied by physicians, and a knowledge of the structure and function of the separate parts has been attained. It is essential, if we are to comprehend the fundamental mechanisms of response of the organism, that we familiarize ourselves with the laws which govern the relationship of all these organs as they are expressed in each individual, and we must accustom ourselves to study man as a living organism.

Living beings have the capacity of expressing their integral unity as individuals, and in the case of man there are special mechanisms of adjustment, collectively designated as the personality. The complex adjustments synthesized in the personality may easily be deranged by interference with the activities of organs or by disturbing the capacity for adaptation; the chief function of sense organs, brain and nervous system. We all know how intimately dependent human beings are upon their environment. Changes in the latter call for delicate and immediate adaptation, and it may be said the problems of psy-

chiatry relate to the determination of the causes which give rise to imperfect adjustments.

A great blessing was conferred by science upon humanity when the problems of psychiatry were restated in biological terms. Life was recognized as a process of adjustment, relatively perfect in health and imperfect in disease; while that metaphysical term insanity arbitrarily reserved to designate certain forms of unsuccessful adjustment was cast into the rubbish-heap together with the chains, straight-jackets and hand-cuffs which had long tortured the lives of patients. Out of hazy mystical conceptions entertained in regard to the nature and genesis of activities described as thought and conduct sprang new ideas potent to inspire the minds of investigators, capable not only of bringing about great practical reforms in the care of the insane, but also in improving the methods for attacking the problems relating to human thought and conduct.

As the ultimate success of the work to be carried on in this clinic, more than in any other department of the hospital, will depend upon cooperative endeavor, I may be permitted to emphasize what seems to me to be an important factor in organization and administration. The patients presenting themselves for treatment are subjects of imperfect adjustments in the life process. The time during which they remain under observation in these wards will represent relatively brief epochs of life, and the records of cases will often give but cursory glimpses into the genesis, duration and progress of imperfect life adaptations. In order to serve the high purpose for which it is planned and dedicated this clinic should be regarded as an important link in a chain of agencies, home, school, college, other hospitals and institutions; in fact the entire social organization with which it is essential constant sympathetic contact should be maintained. Only by the establishment of these relationships can progress in the study of life processes be made.

May we express the hope that in attempting to estimate the value of the work accomplished in this clinic the public expression of opinion should be tempered by charity and patience. Although the field of investigation, which includes the consideration of the factors determining human thought and conduct is the most interesting one in modern medicine, let us not forget that it is the last one to be thrown open to investigators.

The methods of investigation necessarily employed will not appeal to the imagination of the public. The inspiration essential to solve the problems of modern psychiatry will probably not flash into consciousness as did the visions that guided the observer watching the lamps swing in the cathedral or the apple fall from the tree, but it will come gradually only after patient quiet effort, similar to that which finally rewarded the author of "The Origin of Species," and gave a new meaning to life. The realization of the ideals to which we do homage to-day will mark the time when, in Goethe's words,

> Vernunft fängt wieder an zu sprechen,
> Und Hoffnung wieder an zu blühn.

Stewart Paton

TENTH INTERNATIONAL VETERINARY CONGRESS

The organizing committee of the Tenth International Veterinary Congress to be held in London, August 3 to 8, 1914, made a strong appeal to the veterinary profession of the different countries to organize national committees as early as possible in order that an appropriate propaganda may be carried on for the congress, and thereby a large attendance assured.

In view of this and the consideration that the annual meeting of the American Veterinary Medical Association will not take place until September, 1914, it was deemed advisable to organize without delay a national committee for the United States. At the advice of Dr. John R. Mohler, president of the American Veterinary Medical Association, Dr. L. Van Es, who was the official representative of the Ninth International Veterinary Congress at The Hague, was asked to accept the chairmanship, to which he willingly consented, at the same time requesting me to act as the secretary of the national committee.

Dr. Van Es named the following vice-presidents for that committee: Dr. A. D. Melvin, Washington, D. C.; Dr. K. F. Meyer, Philadelphia, Pa.; Dr. C. J. Marshall, Philadelphia, Pa.; Dr. J. R. Mohler, Washington, D. C.; Dr. J. Hughes, Chicago, Ill.; Dr. W. H. Dalrymple, Baton Rouge, La.; Dr. E. C. Schroeder, Washington, D. C.; Dr. V. A. Moore, Ithaca, N. Y.; Dr. E. C. Cotton, Minneapolis, Minn.; Dr. J. S. Anderson, Seward, Nebr.; Dr. S. Brenton, Detroit, Mich.; Dr. C. A. Cary, Auburn, Ala.; Dr. D. S. White, Columbus, Ohio; Dr. S. B. Nelson, Pullman, Wash.; Dr. M. Francis, College Station, Texas; Dr. W. F. Crewe, Devils Lake, N. Dak.

With the organization completed, the committee now desires to commence their work and to create a wide interest among the veterinarians of the United States, thereby securing a creditable delegation from our profession.

Sir Stewart Stockman, honorary secretary of the organizing committee, in a letter addressed to Dr. A. D. Melvin, expressed his desire to obtain at an early date the names of those who desire to act as reporters for the various subjects to be discussed at the congress, also at the same time enclosing a copy of the list of subjects which are to be discussed at the Tenth International Veterinary Congress. The list is prepared as follows:

GENERAL MEETINGS

1. Foot and mouth disease.
2. Tuberculosis, including the relationship of the so-called types of tubercle bacilli.
3. Epizootic abortion.
4. Public control of the production, distribution and sale of milk in the interests of public health.

Section I.—Veterinary science in relation to public health.

1. Meat poisoning—its pathogenesis and the measures necessary to guard against it.
2. General principles to be observed in the inspection of the carcasses and organs of tuberculous animals with a view to determining their safety as articles of human food.
3. Disinfection of wagons.

Section II.—Pathology and bacteriology.

1. Johne's disease.
2. Bovine piroplasmoses (European), with special reference to their etiology.
3. Ultra-visible viruses.
4. Distemper—etiology and vaccination.

Section III.—Epizootiology.

1. Anthrax.
2. Swine fever.
3. Glanders.
4. Sarcoptic mange of the horse.

Section IV.—Veterinary medicine and surgery.

1. Anesthesia—local and general.
2. Laminitis.
3. The surgical treatment of roaring.
4. The use of drugs in the treatment of disease caused by nematode worms.

Section V.—Tropical diseases.

1. Diseases transmitted by ticks; their classification, treatment and prevention.
2. Diseases transmitted by winged insects; their classification, treatment and prevention.

It is also planned to arrange in connection with the Tenth International Veterinary Congress a study tour for veterinarians, under the auspices of the Bureau of University Travel, the itinerary of which will include a trip through Belgium, France, Switzerland, Italy, Hungary, Austria, Germany, Holland and England, thereby affording the veterinarians desiring to attend the congress a splendid opportunity of studying all phases pertaining to veterinary medicine in the different countries.

Such a tour will be the first undertaken by a body of veterinarians from this country and would afford splendid advantages to members of the profession, affording not only pleasurable but also educational advantages; be-

sides such a body would receive exceptional courtesies from the authorities abroad.

It is only natural that a competent director of the tour will be named who, with extensive experience in travel abroad and a knowledge of languages, will be in position to care for the welfare of the party in the best possible way.

It is hoped that the members of the profession will aid the committee in its work. Those who desire further information will be given full attention.

Adolph Eichhorn,
Secretary

SCIENTIFIC NOTES AND NEWS

The Paris Academy of Sciences has elected Professor W. M. Davis, of Harvard University, a correspondent in the Section of Geography and Navigation, in the place of the late Sir George Darwin.

The University of California has awarded an honorary degree to Mr. John Muir, "born in Scotland, reared in the University of Wisconsin, by final choice a Californian, widely traveled observer of the world we dwell in, man of science and of letters, friend and protector of nature, uniquely gifted to interpret unto other men her mind and ways."

The Halle Academy of Sciences has awarded its gold Cothenius medal to Dr. Leonhard Schultze, professor of geography at Marburg.

Dr. Otto H. Tittman, chief of the Coast and Geodetic Survey, has been made an honorary member of the Berlin Geographical Society.

The Hanbury medal of the Pharmaceutical Society, London, has been awarded to Dr. Frederick Bilding Power, Ph.D., LL.D. The medal is awarded bienially for original research in the chemistry and natural history of drugs. Dr. Power, who is director of the Wellcome Research Laboratories, London, is an American by birth.

The council of the Royal Society of Arts has passed the following resolution:

On the occasion of the fiftieth award of the Albert medal of the Royal Society of Arts, the council of the society desire to offer the medal to H.M. King George V., for nine years president, and now patron of the society, in respectful recognition of his Majesty's untiring efforts to make himself personally acquainted with the social and economic condition of the various parts of his dominions, and to promote the progress of arts, manufactures and commerce in the United Kingdom and throughout the British Empire.

The gold Nachtigall medals of the Berlin Geographical Society have been awarded to Duke Adolf Friedrich, of Mecklenberg, and Professor Hans Meyer, for explorations in Africa.

Professors J. L. Coolidge, E. V. Huntington and G. D. Birkhoff, of the division of mathematics of Harvard University, have been elected to membership in the American Academy of Arts and Sciences.

The Rumford Committee of the American Academy, at its last meeting, voted the following appropriations: to Frederick G. Keyes, of the Massachusetts Institute of Technology, $300 to be used for the payment of assistants in the computation of thermodynamic tables for ammonia, and to Professor Theodore W. Richards, of Harvard University, $100 to be used in aid of the publication of the Annual International Tables of Constants.

Secretary Lane has announced a reorganization of the reclamation service. F. H. Newell, director of the Reclamation Service, will be chairman of a new Reclamation Commission. The commission will consist of five members, who, besides Chairman Newell, will be George Barton French, in charge of operation and maintenance; A. P. Davis, chief engineer; Judge Will R. King, of Oregon, chief counsel, and one other, who will have charge of the contracts and finances.

Dr. W. D. Bigelow, for many years a member of the Bureau of Chemistry, U. S. Department of Agriculture, has resigned from the government service to take charge of the laboratory of the National Canners' Association to be established in Washington.

MR. NATHAN C. GROVER, of New Jersey, has been appointed chief hydraulic engineer of the water-resources branch of the U. S. Geological Survey, to succeed Mr. Marshall O. Leighton, who resigned early in May to plan and supervise land drainage in Florida.

MR. C. G. ELLIOTT, chief of drainage investigations in the Department of Agriculture, has left the government service to go into private business.

MR. E. N. WENTWORTH, associate professor of animal husbandry at the Ohio State College, has become associate editor of *The Breeders' Gazette.*

DR. T. N. CARVER, David A. Wells professor of political economy at Harvard University, has been appointed director of the Rural Organization Service, a new branch of work just organized by the federal Department of Agriculture, and has been granted leave of absence from the university so that he may be able to carry on the new work he has undertaken.

MR. L. F. RICHARDSON, assistant lecturer in physics at the Municipal School of Technology, Manchester, has been appointed superintendent of the Geophysical Observatory, Eskdalemuir, in succession to Mr. G. W. Walker, resigned.

MR. T. L. ECKERSLEY, B.A., of Trinity College, Cambridge, has been appointed assistant at the Helwan Observatory, Egypt, to assist in the magnetic work.

PROFESSOR VON DUNGERN, of Heidelberg, has been appointed director of the newly established institute for experimental cancer research at Hamburg-Eppendorf.

DR. W. A. MURRILL, assistant director of the New York Botanical Garden, has sailed for Europe to study especially the conditions of the growth of trees in cities.

THE Academy of Science of Oregon has elected officers as follows:

President—N. H. Laurie.
First Vice-president—A. R. Sweetzer.
Second Vice-president—T. D. Beckwith.
Third Vice-president—W. L. Finley.
Secretary—Miss Jane Stearns.
Treasurer—A. L. Knisley.
Librarian—A. W. Miller.
Trustees—A. L. Knisley, E. A. Beals, J. D. Lee.

THE results of the election for the Ohio State University Chapter of the Sigma Xi Society was as follows:

President—C. S. Prosser, professor of geology.
Vice-president—John F. Lyman, professor of agricultural chemistry.
Secretary—W. M. Barrows, instructor in biology.
Treasurer—John A. Wilkinson, assistant professor of chemistry.

THE Minnesota Chapter of the Sigma Xi met on May 29 for its annual banquet and initiation of new members. At the same time researches of three of the initiates was presented as follows:

"A Successful Case of Applied Entomology," C. W. Howard.

"Parasitism in Rusts," E. C. Stakman.

"Sunlight as a Factor in Plant Metabolism," R. W. Thatcher.

At Minnesota, research is essential for the election to Sigma Xi.

DR. JAMES W. JOBLING, of Michael Reese Hospital, Chicago, Ills., gave the annual address before the Minnesota Pathological Society on May 20. His subject was "The Toxicity and Antigenetic Properties of the Cleavage Products of Bacterial Proteins."

PROFESSOR G. H. PARKER, of Harvard University, addressed the Brown Chapter of Sigma Xi, at the University Club, Providence, on May 28, on a "Biological Forecast."

PROFESSOR G. W. PIERCE, of Harvard University, has delivered three lectures on "Wireless Telegraphy and Wireless Telephony" before the student officers of the post-graduate department of the United States Naval Academy at Annapolis, Md.

A LARGE bronze mural tablet to the memory of the late Dr. John Herr Musser, professor of clinical surgery in the University of Pennsylvania, has been presented to the University Hospital. The tablet was designed by Dr. R. Tait McKenzie.

LORD AVEBURY, formerly Sir John Lubbock, distinguished for public services in many di-

rections, including a large number of contributions to natural science and books of popular interest, died on May 28, aged seventy-nine years.

Dr. Max Thomas Edelmann, professor of physics in the School of Technology of Munich, has died at the age of sixty-eight years.

Dr. H. Weber, professor of mathematics at Strassburg University, died on May 17, at seventy-one years of age.

M. Alfred de Foville, permanent secretary of the Académie des Sciences Morales et Politiques, an eminent economist and statistician, has died at the age of seventy-one years.

The death is announced of Friedrich Wilhelm Ristenpart, director of the Observatory at Santiago, Chili.

The U. S. Civil Service Commission announces an examination for soil biochemists at salaries ranging from $1,800 to $2,200 a year, in the Bureau of Soils, Washington, D. C.

The Canadian Medical Association will hold its forty-sixth annual meeting in London, Ontario, on June 24, under the presidency of Dr. H. A. McCallum.

The American Medical Association will hold its sixty-fourth annual session at Minneapolis from June 17 to 20, under the presidency of Dr. John A. Witherspoon. The work of the meeting will be distributed among the following sections: The practise of medicine, surgery, obstetrics, gynecology and abdominal surgery, ophthalmology, laryngology, otology and rhinology, diseases of children, pharmacology and therapeutics, pathology and physiology, stomatology, nervous and mental diseases, dermatology, preventive medicine and public health, genito-urinary diseases, hospitals and orthopedic surgery.

A tidal observatory, the first of its kind in Great Britain, erected near the Castle, Dunbar, has been opened. One of the main objects of the observatory will be to afford a means of examining local vertical movements of the coastline, if any occur, as recommended by the royal commission on coast erosion.

The Nathan Lewis Hatfield prize of the College of Physicians of Philadelphia, amounting to $500, will be awarded in 1916. The deed of trust requires that the prize shall be on a subject of general medicine, medical pathology or therapeutics, the treatment to embody original observations, or researches, or original deductions. Competition for the prize is open to the medical profession and men of science in the United States. The original of the successful essay becomes the property of the College of Physicians. All manuscripts must be sent by May 30, 1915, to the committee, which consists of William G. Spiller, M.D. (chairman), Allen J. Smith, M.D., and William Pepper, M.D.

An association, called the Union Médicale Franco-Ibéro-Américaine, has, as we learn from the *British Medical Journal*, recently been formed in Paris for the purpose of uniting the doctors of the republics of Central and South America with Spanish and French physicians in a scientific alliance of Latin races. From the initial letters of its title it is called for shortness "Umfia." The president is Dr. L. Dartigues; the general secretary is Dr. Gaullier l'Hardy; the vice-presidents, Drs. Bandelac de Pariente (physician to the Spanish embassy in Paris), Manrique and Delaunay. Among the members of the honorary committee are the Spanish ambassador to the French republic; Professor Ortega Morejon, member of the Spanish Academy of Medicine; Dr. Pulido, senator of Spain; Dr. Risquez, sometime rector of the University of Caracas, together with the dean of the Paris Faculty, Professor Landouzy, and Professors Ch. Richet, F. Widal, A. Robin, Pozzi, Pierre Marie, Pinard, Legueu, Doléris and Bazy, and Dr. Roux, director of the Pasteur Institute. Membership is open to all doctors throughout the world who speak Spanish or Portuguese. At present there exist more than twenty autonomous nations of Spanish speech, and it is estimated that the language is spoken

by more than a hundred million persons. It is propesed to estabish a Hispano-American Hospital, to arrange scientific tours and to make summaries of all medical papers written in Spanish available for members. The objects of the Umfia are to make its members known to each other, to establish relations, social and scientific, with the doctors of every country where Spanish is spoken; to establish an information bureau for Spanish or Portuguese doctors who go to Paris to pursue clinical work and research; to arrange courses of instruction, lectures, meetings, festivities and congresses, and to organize means of assistance to foreigners of Spanish-American origin settled in Paris who may be in need of help.

WE learn from *Nature* that the famous prehistoric camp, known as Maiden Castle, near Dorchester, has been, at the suggestion of King George, purchased by the Duchy of Cornwall, and will now be carefully preserved. The camp dates from Celtic times, and formed a shelter for cattle during tribal raids rather than a military fortress. Water was supplied from a neolithic dew-pond on the summit of the plateau, and the palisading kept at bay wolves and other enemies, while the cattle were left in charge of a few women and children. The cunningly arranged entrances to the camp supply a remarkable example of primitive methods of defence.

UNIVERSITY AND EDUCATIONAL NEWS

THE special state appropriation bills for the University of California, as signed by the governor, provide amounts as follows: support and maintenance of the university, $400,000; agriculture (support and maintenance of all branches), $700,000; New North Hall, $400,000; impairment of income, $62,000; replacement of buildings and equipment at Lick Observatory, $50,000; university extension, $50,000; Los Angeles medical department (support), $20,000; Los Angeles medical department (new buildings), $25,000; Scripps Institution for Biological Research, $15,000; printing, $12,000; one dormitory at Davis, $40,000; dining hall at Davis, $10,000; classroom and library buildings at Davis, $65,000; small buildings at Davis, $20,000; 200 acres for experiment station in southern California, $60,000; laboratory building for experiment station in southern California, $100,000; residence, barns, etc., for experiment station in southern California, $25,000; total special appropriations, $2,054,000. To these appropriations there must be added the state university fund to be automatically appropriated during the coming two years for the support and maintenance of the university amounting in total to $1,802,978. The grand total appropriated by the state of California for the University of California for the next biennium is therefore $3,856,978.

YALE UNIVERSITY will receive $475,000 from the estate of Dr. Francis Bacon, who died last year. The sum will be available for almost immediate use.

MRS. MARY EMERY has contributed $125,000 to the Ohio-Miami Medical College of the University of Cincinnati for the endowment of a chair of pathology. A sum of about $80,000 from the estate of Dr. Francis Brunning has also been received by the university, the income of which will be used for the endowment of a second chair.

THE general faculty of Oberlin College has voted to recommend to the trustees that this year all honorary degrees be omitted at commencement.

MR. KERR DUNCAN MACMILLAN, assistant professor of church history in the Princeton Theological Seminary, has been elected to the presidency of Wells College.

DR. JAMES H. WOODS has been promoted to be professor of philosophy at Harvard University.

DR. CHARLES AUGUSTUS TUTTLE, professor of political economy and political science at Wabash College, Crawfordsville, Ind., has been elected professor of economics and social science at Wesleyan University.

Dr. J. Argyll Campbell, junior assistant to Professor Schäfer at Edinburgh University, has been appointed professor of physiology in the University of Singapore.

W. Dawson, M.A., D.Sc. (Agr.), has been appointed to succeed Mr. A. Henry as reader in forestry at Cambridge University. Mr. Dawson has held a similar position at Aberdeen University.

Professor Strasburger, of Breslau, has accepted the position of director of the newly-established medical policlinic and therapeutic course at Frankfort-on-the-Main, which are to be considered a department of the proposed university.

Professor Kaiserling, of Berlin, has accepted the appointment as successor of Professor Henke at the Cologne Institute of Pathology.

DISCUSSION AND CORRESPONDENCE

TYPES OF SPECIES IN BOTANICAL TAXONOMY

It is becoming more and more evident that only by the use of the method of types[1] can any stability be secured in taxonomy. In spite of a growing realization of this fact there has been no adequate appreciation on the part of botanists of the great advantages offered by plants over animals in the facilities they afford for the multiplication of type material.

Primary Types

Although the author of a new species usually has at his disposal several different specimens upon which he bases his description, nevertheless only a single twig or shoot together with any organs borne on it can be considered to be the true type specimen. It is not permissible to accept as parts of the type other twigs or stems, for it often happens that they were not collected from the plant that yielded the true type specimen and subsequent research may show them to belong to a different variety or even to a different species. Experience has shown that the author of a species is far from infallible, and that to accept his verdict on this point may give rise to a complete misunderstanding of the species on the part of later investigators and cause endless confusion in the subsequent literature.

Even in case of diœcious or polymorphous plants where it is obviously impossible for a single specimen to represent all of the essential characters of the species, the twigs cut from different forms are not to be considered as parts of the type specimen. It is easy to see that where several species occur in the same region it is not always possible for the author of the species to be sure that the different sexes or castes[2] represented in the material at his disposal really belong to one and the same species. It is necessary to designate some one specimen as the type and to associate with it as paratypes additional specimens of the other sex or of the other castes that seem undoubtedly to belong to the same species Usually the pistillate specimen will be designated as the type.[3]

Even in case of a number of specimens presumably cut from the same plant it is unsafe to consider more than one of them as the type since there is always the chance that two plants growing close together were not distinguished. Abnormalities or bud variations on the type plant might also be overlooked, particularly if the collector, not realizing that he was dealing with a new species, exercised no unusual care.

The type specimen is therefore unique, and can not exist in duplicate. Types are the

[1] Cook, O. F., 1898, "The Method of Types," in Science (N. S.), 8: 513–516, No. 198, October 14. Cook, O. F., 1900, "The Method of Types in Botanical Nomenclature," in Science (N. S.), 12: 475–481, No. 300, September 28.

[2] Cook has discussed in some detail the various castes of plants having definitely specialized heterism (ropism). Cook, O. F., 1907, "Aspects of Kinetic Evolution," in *Proceed. Wash. Acad. Sci.*, 8: 369–378, February 13.

[3] The term allotype, although proposed for paleontological material, might very properly be applied to any paratype possessing some very important organ or distinctive feature not present in the type itself. Burling, Lancaster D., 1912, "The Nomenclature of Types," in *Journ. Wash. Acad. Sci.*, 2: 519–520, No. 21, December 19.

most valuable possession of museums and constantly increase in value as years elapse. They should not be left in the herbarium with the ordinary specimens, but should be so mounted as to be protected from injury in handling[4] and should be kept in fire-proof cases, if possible in a special room where they may be consulted in the presence of a custodian who can help to preserve all fragments of the type material.

The type plant from which the type specimen was secured has a far greater importance than a type animal. Very often additional specimens almost exactly duplicating the type can be secured from it. These are merotypes[5] and if used by the author of the species in drawing up the original description become paratypes as well. Carefully selected merotypes collected at the same time as the type specimen and used by the author as paratypes are, properly speaking, duplicate types, having practically the same value from a taxonomic standpoint as the type itself, and should receive the same treatment in museums.

If the original type is lost during the life of the author of the species it is often possible to secure substitute types collected from the very spot where the type was secured. It is sometimes possible to secure merotypes from the plant that yielded the original type. As a rule no such satisfactory substitute types can be obtained after the death of the author of the species.

Besides merotypes proper, cut from the type plant as it stands, it is often possible to secure specimens from its vegetatively propagated offspring. Such clonotypes,[6] as they have been called, may be secured from plants that reproduce naturally by bulbs, offshoots, tubers, etc., as well as from those propagated artificially by grafts or cuttings. Clonotypes can thus be obtained in unlimited numbers and are usually only slightly less representative than merotypes proper.

Specimens taken from seedlings of the type plant have been called spermotypes. They are of interest in case of short-lived species too small to furnish many merotypes and unable to yield clonotypes. Such seedlings if compared with the type and found to agree with it in all essential characters yield spermotypes almost as representative as clonotypes or merotypes. Spermotypes of diœcious or polymorphic species have unusual value since the seeds obtained from the female plant that yielded the type specimen can usually be depended upon to reproduce the species unchanged, with of course both the constituent sexes or all the polymorphic forms represented among the seedlings.

Reproduced Types

Besides the additional material obtained through the subdivision of the type plant or by its propagation vegetatively or from seed there are other important means for the wide distribution of type material.

Photographs may be taken of the type specimens and, inasmuch as the camera is able to reproduce all the detail visible to the unaided eye and does it mechanically, these phototypes,[7] as they have been called, are of much value, especially as they can be reproduced indefinitely.

Phototypes are rendered still more valuable if they can be supplemented by a fragment of the type taken from a position definitely marked on the photograph. Such specimens have been called clastotypes. They can have, of course, only a limited distribution, since very few fragments can be spared from a type specimen.

[4] Kellerman, Maude, 1912, "A Method of Preserving Type Specimens," in *Journ. Wash. Acad. Sci.*, 2: 222–223, No. 9, May 4.

[5] Swingle, Walter T., 1912, "Merotypes as a Means of Multiplying Botanical Types," in *Journal Wash. Acad. Sci.*, 2: 220–222, No. 9, May 4.

[6] Swingle, Walter T., 1912, "Clastotypes, Clonotypes and Spermotypes, Means for Multiplying Botanical Type Material," in the *Journal Wash. Acad. Sci.*, 2: 337–339, No. 14, August 19.

[7] Kellerman, Maude, 1912, "Phototypes, Means for Wide Distribution of Type Material," in *Journal Wash. Acad. Sci.*, 2: 339–40, No. 13, August 19.

A representative merotype properly authenticated may be illustrated by nature prints, discovered by Auer and Worring and so beautifully applied by Ettinghausen and Pokorny,[8] whereby all the minute details of venation are shown in exact mechanical reproduction, and an indefinite number of copies can be made for distribution. This method, marvellous as it is, can not be used for the type itself, as the specimen may be destroyed or at least injured in the process of making the plate.[9]

Such a nature print, for which the term piesmotype[10] is suggested, is eminently adapted for the reproduction of an authentic merotype. This piesmotype, together with a phototype, gives an authentic, unbiased and very vivid picture of the type of the species.

Finally, in case of cones, nuts, or other organs showing relief sculpture, casts may be taken; these are the plastotypes of Schuchert.[11] They are probably of greatest value in reproducing types of fossil plants, although they can be made from almost any glabrous plant organ.

Syntypes and Paratypes

If, as is usually the case, several specimens from distinct plants and often from different localities are used by the author in describing his species the type material belongs to one of two categories. Either the author did not directly or indirectly designate a type and therefore all the specimens are syntypes,[12] or a type was designated, in which case the other specimens studied by the author are paratypes.[13]

What are here called syntypes are also known as cotypes,[14] but unfortunately the latter word is also very commonly, though erroneously, used to designate paratypes. In earlier times when the author of a new species rarely designated a type all of the specimens were very properly known as cotypes. It was easy to continue to apply the name to the specimens, even when the author had designated one of them as a type. Such a practise leads to confusion and should be abandoned, and a more precise and definite terminology used.

Although syntypes are usually segregated sooner or later into a type (lectotype[15]) and paratypes, it is nevertheless important to avoid any confusion in type material such as is likely to result from using the term cotype. It would, indeed, be better to abandon altogether the word cotype.

The rules that have been formulated for the typification of species, particularly those given in the American code of botanical no-

[8] Ettingshausen, C., and Pokorny, A., 1856, "Physiotypia plantarum austriacarum. Der Naturselbstdruck in seiner Anwendung auf die Gefässpflanzen des oesterreichischen Kaiserstaates." F°, 5 vols., Wien.

[9] The thoroughly dry herbarium specimen is forced into a plate of soft lead by great pressure exerted by a slow-moving roller, then an electrotype is made in hard metal from the lead original and impressions are made from the electro as is done from an engraved copper plate.

[10] Piesmotype (πιεσμός, pressure; τύπος, type); a picture printed from a plate bearing an imprint made by mechanical means from an authentic merotype.

[11] Schuchert, Charles, 1897, "What is a Type in Natural History," in Science (N. S.), 5: 636–640, No. 121, April 23.

[12] [Bather, F. A.], 1894, "Scientific Volapuk," in *Natural Science*, 4: 57, No. 23, January.

[13] "A *para-type* is a specimen belonging to the original series, but not the type, in cases where the author has himself selected a type. It should, however, be one of the specimens mentioned or enumerated in the original description." Thomas, Oldfield, 1893, "Suggestions for the More Definite Use of the Word 'Type' and its Compounds as Denoting Specimens of a Greater or Less Degree of Authenticity," in *Proc. Zool. Soc.*, 1893, p. 242, Pt. 2, No. 17, August 1.

[14] "A *co-type* is one of two or more specimens together forming the basis of a species, no *type* having been selected. No species would have both type and co-types, but either the former, or two or more of the latter." Thomas, Oldfield, *l. c.*

[15] Schuchert, Charles, in Merrill, Geo. P., 1905, Catalogue of the Type and Figured Specimens of Fossils, Minerals, Rocks and Ores in the Department of Geology, United States National Museum, Bull. 53, Part I., Fossil Invertebrates, p. 12.

menclature, suffice in very many cases to determine which of the syntypes is to be made the lectotype.[16]

Supplementary Typical Material

Besides the type material proper there are the so-called supplementary types (plesiotypes) and typical specimens (topotypes, etc.) which have been treated in detail by Schuchert. These need not be considered here, as they are merely specimens judged, with more or less show of reason, to be like the type. Often, perhaps usually, they do not belong in the type collection at all.

To summarize briefly the different kinds of type material we have:

I. *Type Material Proper*

1. Primary types, specimens used by the author in describing a new species, including either (*a*) the true *type* (with its *clastotypes*) and *paratypes*, or (*b*) the *syntypes*.

2. Additional types, specimens taken from the type plant or from its offspring, including *merotypes, clonotypes* and *spermotypes*.

3. Substitute types, specimens selected as types when the type was not designated, including *lectotypes*.

4. Reproduced types, mechanical reproductions of types, including *phototypes, piesmotypes* and *plastotypes*.

II. *Supplementary Typical Material*

5. Supplementary types, specimens used as a basis for descriptions or figures of previously published species, *plesiotypes*.

6. Typical material, specimens (from the type locality if possible) considered to be like the type, *topotypes*, etc.

WALTER T. SWINGLE

[16] Arthur, J. C., et al., 1907, "American Code of Botanical Nomenclature," in *Bull. Torrey Bot. Club*, 34: 172–174, No. 4, April, published June 11.

MOSQUITOES POLLINATING ORCHIDS

EARLY in July, 1912, Miss Ada K. Dietz, who was doing research work in plant ecology at the University of Michigan Biological Station at Douglas Lake, told me that she had seen in Rees's Bog a mosquito bearing on its head two small yellow masses that looked like pollen. I went to the bog and found many mosquitoes there. In a few minutes I had caught a half dozen or more, all of them females, bearing the yellow masses. On closer examination these proved to be pollinia of the orchid, *Habenaria obtusata* (Pursh.) which was at that time abundant in the bog and in full bloom. Most of the mosquitoes carried one pollinium, some had two or three, and one had four pollinia attached to its eyes.

This orchid is small, green and inconspicuous, but very similar in the structure of its flower to *Orchis mascula*, described by Darwin in his book on the "Fertilization of Orchids," and by Müller in "The Fertilization of Flowers." Also, the complex process of pollination as described in the last named book (p. 535) for *O. mascula* might apply almost unchanged for *H. obtusata* with mosquitoes instead of bees for the pollen-bearers.

I gathered a number of the plants and a few mosquitoes that were free from pollinia and put them together in a glass aquarium jar. In a few days the mosquitoes had removed most of the pollinia from the flowers and now bore them on their eyes exactly as had those caught outside.

I did not learn the name of the mosquito concerned. It was probably not *Culex pipiens*, which is mentioned by Müller as a visitor to the flowers of *Rhamnus Frangula*. So far as I know, this is the only case reported in which mosquitoes seem to be of primary importance as agents of pollination.

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SCIENTIFIC BOOKS

The New Realism: Cooperative Studies in Philosophy. By E. B. HOLT, W. T. MARVIN, W. P. MONTAGUE, R. B. PERRY, W. B. PITKIN and E. G. SPAULDING. New York, The Macmillan Company. 1912.

The World We Live In. By GEORGE STUART FULLERTON. New York, The Macmillan Company. 1912.

The first of these contributions to philos-

ophy should have a somewhat exceptional interest for men of science. For it makes use of data drawn from the special sciences more than is the wont of philosophical books; it represents an attempt to introduce something more closely resembling the scientific method and temper into philosophical inquiry; and it is chiefly devoted to the establishment of a conclusion which, if accepted, would apparently necessitate the relinquishment of certain modes of thought and speech frequently used in the interpretation of the methods and results of scientific observation. In the spirit and procedure of the authors there is much that is both rare and laudable. Real, organized cooperation in philosophizing—the provisional segregation of definite questions, and an attempt to reach a collective answer to them by methods which have borne the test of open discussion at close quarters and of repetition by other inquirers—this is still a sadly unaccustomed practise among philosophers; there are even those who deem it impossible and of dubious desirability. Whatever else they have done, the six authors of "The New Realism" have in this matter set the philosophical world an example which it is to be hoped will be not only praised but imitated. Nor is it only in their cooperation that they have carried over the temper of science into the business of the philosopher. The book for the most part is singularly free from those *arrière-pensées* which often vitiate, even though they enrich and make more humanly interesting, philosophic reflection. There is almost no trace of the desire to edify, no great solicitude as to the immediate bearing of their results upon "life," no tendency to confuse philosophy with either poetry or preaching. The writers seem desirous merely of reaching a verifiable conclusion upon a specific issue. With complete intellectual detachment they can not, indeed, quite be credited; they have, after all, a *parti pris,* and at least one of the six writes much in the style and spirit of the special pleader. But since they have a common cause to sustain, the openness with which they acknowledge its initial difficulties and disclose their inability to agree upon a common solution of those difficulties, is the more admirable. One's admiration would, indeed, have been still greater if this had led to an actual suspension of judgment upon the main issue, as the final result of the cooperative effort—which, as will appear, is the result towards which, at most, the course of the argument would seem to point. But this, perhaps, is more than it would be reasonable to expect. Even as it is the book is an almost unique example of a genuine and persistent attempt at close thinking *together*—at a literally "dialectic" process—on the part of a considerable number of philosophers, of whom none stands in the relation of master to the others.

The point in the "new realism" which constitutes both its novelty and its chief significance for natural science is, not its realism, but its doctrine about consciousness. For that doctrine, if accepted, entails the abandonment of certain conceptions still extensively used by science as well as by common sense. It has been, moreover, the generating principle of the whole theory, from which all of its principal conclusions and most of its characteristic difficulties have arisen. It is the more important to recall this fact because, while this theory of consciousness clearly underlies much of the reasoning in the volume, it is not altogether definitely and connectedly stated here (though it has been so stated in previous writings of some of the group), and it seems at times to be forgotten altogether.

The doctrine in question is this: that what is commonly called "consciousness" is simply a particular mode of relation; and that it is an "external" relation, *i. e.,* one which does not constitute or in any way alter the terms which at any time happen to enter into that relation. From this doctrine follow directly the two essential articles in the new realism's account of the nature of the transaction called sense-perception—its affirmation, at once, of the "independence" and of the "immanence" of the object perceived. Given the conception of consciousness as merely an otiose relation among items totally unaffected thereby, and

the object necessarily must be independent; for such a relation is not a thing upon which anything *could* depend. No less obviously must the object be immanent; *i. e.*, must at the time of perception be "numerically" and in all other respects identical with the percept. For there is nothing in an external relation which could produce duplicates or "images" of the terms related. Thus the root-doctrine of this new philosophy is "the relational theory of consciousness," which branches out into the two derivative doctrines of realism and epistemological monism (*i. e.*, the doctrine that object and idea or percept are one identical entity). Not only does it produce these secondary conclusions; it apparently provides their chief support. I, at least, am unable to find in the volume much *positive* argument (as distinct from proofs of the inconclusiveness of certain arguments of idealism and dualism) for the object's independence and immanence, except deductions from the relational theory of consciousness. Upon the validity of this theory, then, the constructive part of the new realism depends. I shall accordingly limit the present examination of this collection of reasonings to two questions: (1) What positive reasons are offered for the opinion that consciousness is merely an external relation? (2) How do the new realists meet the usual arguments—not of idealism, but of common sense—for the view that consciousness can not possibly in all cases be an external relation, that, in other words, *some* content of consciousness must be regarded as existing only in and by means of consciousness?

1. With regard to the first point, one must first of all complain that the relational theory of consciousness is left, in two important respects, in great obscurity. It still remains difficult to determine just *what kind* of relation *to* what, the consciousness-relation is supposed to be. So far as the authors approach definiteness upon this, they also seem to diverge from one another. But I do not here wish to dwell upon this consideration. More serious is the uncertainty in which the reader is left with respect to another question. Is consciousness held to be *wholly and in all cases* non-constitutive of the content that is in consciousness? Does the new realism mean to reject the notion of "purely subjective existence" *in toto*, and to maintain that all experiences are equally independent and objective, that only things, and not thoughts, exist at all? For Perry, the answer appears to be negative; this view, he observes, "is not part of realism." "Values," "interests," "higher complexes, such as history, society, life or reflective thought," all these *are* "dependent on consciousness." Independence, then, is not universally predicated of things experienced; all that is maintained is that "*in certain notable cases, at least,* things are none the less independent for being perceived." But this is an immense and fatal qualification of the relational theory. For if consciousness is *capable* of having content that depends upon it for existence, that is purely its own, one obviously can not argue from a general incapacity of consciousness to constitute its own content to the conclusion that the objects of perception are independent, etc. The nerve of the main positive argument for both realism and epistemological monism is thus cut. If consciousness is in some cases an external and in some cases a constitutive "relation," it becomes necessary to adduce specific empirical evidence to show that in each and every case of perception it is of the former sort. And no such evidence is offered. Strictly empirical evidence, indeed, it is manifestly impossible to offer; since things are always experienced in the consciousness-relation, experience, at least, can not testify to their independence of and externality to that relation. If, then, we take the external-relation theory in Perry's sense—as meaning merely that consciousness *may be* an external relation—we must admit the theory to be true. There are, doubtless, external relations; and it is conceivable that "being in consciousness" may sometimes be one of them. But from this "may-be" no proof of the neo-realistic theory of perception can be drawn; yet no other positive proof is given.

Others of the group, therefore, avoid

Perry's damaging concession. Pitkin, for example, declares that "the realist can not count his case won" until he has shown "the complete independence of all things thought of." He feels obliged, therefore, to hold that even hallucinatory objects, and errors of all sorts, are "no less independent of cognition than true propositions are." That secondary qualities, illusory presentations, and the like, can all be, without contradiction, conceived as objective and independent, Montague, Holt and Pitkin alike are concerned to show; and the only imaginable reason for their undertaking to justify this paradox is an acceptance of the view that consciousness is *in no case* constitutive of any perceived content, that it is always and absolutely a relation which does not create its terms nor modify their other relations.

But for this more rigorous construction of the relational theory, what evidence is offered? It, if established, would prove neo-realism's case, as I have admitted; but by what argument is this all-important premise itself to be established? Of general and positive arguments for it there are, so far as I can see, none in the book. Direct empirical evidence is, once more, unattainable, in the nature of the case, and is not attempted. What we are given is merely a series of attempts to show that the theory is not absurd, that the general and unqualified assertion that no perceived datum ever does or can depend upon its relation to a perceiver for its existence or any of its attributes or its other relations, is not the extravagance which it at first appears to be. Even if these attempts be regarded as successful, they could not, by a rigorous logician, be regarded as establishing the conclusion desired. There are many propositions which are not absurd which are also not true. The battle for the relational view of consciousness can hardly be won by purely defensive tactics. But are even those tactics successful? To this question we must now turn.

2. Science, I have said, as well as popular thought, is still, as a rule, accustomed to think of some of the content of experience as existing "merely subjectively." The whole distinction between appearance and reality—in the ordinary, empirical sense—which science has found so indispensable has usually taken the form of the supposition that certain data of perception,—*e. g.*, the secondary qualities of matter, illusions, dreams, hallucinations—can be explained away as having their being only in "minds" and by virtue of minds, as *being* only in so far as, and only in the sense that, somebody is conscious of them. This, then, is the way of thinking and of speaking which the new realism (in so far as it treats its relational theory of consciousness as a universal proposition) invites us to give up. It therefore proposes a radical revision of widely current preconceptions. The important question to raise concerning it, then, is this: Can we, while maintaining realism, *completely* dispense with the idea of "subjective appearance," of "mental representations" of objects, can we hold without self-contradiction that what things seem they also are, and that the entity present "in consciousness" whenever we perceive or think of an object is just the original, simon-pure object itself, untransformed, unduplicated and untransposed?

That their doctrine stands or falls with the answer to this question, the authors very frankly acknowledge. "The crucial problem," says Pitkin, "for the new realism is the problem of error (in all forms). And the acutest critics" of the doctrine "urge that its fatal flaw is the acceptance of the full 'objective' nature of illusions and errors and its simultaneous refusal to put illusory objects, with all their colors, shapes and behaviors, identically in the very space and time in which they immediately belong. If the charge is true it is deadly." To meeting this type of objection the papers of Montague, Holt and Pitkin are chiefly devoted.

Unfortunately space is lacking here for an adequate analysis of these highly ingenious and rather involved pieces of argumentation; that examination must be attempted elsewhere. For the present it must suffice to observe that these three writers are unable to agree upon any one "solution of the problem of error" in terms which shall be consistent with

their general doctrine. Each repudiates the solutions of the others; each, therefore, from the point of view of the others, has no logical right to be a new realist, since he fails (in their eyes) to meet satisfactorily an objection which admittedly must be met before the new realism can be regarded as tenable. So long as these spokesmen of a common cause, after prolonged conference and discussion *inter se*, are unable to convince one another, no one of them will feel it surprising that he fails to convince his readers. Nor is this the worst of the situation. In an appendix definite refutations are offered of all three solutions; Montague refutes Holt and Pitkin, and Pitkin refutes Montague. This does infinite credit to their candor and philosophical good faith; but it leaves their doctrine in a parlous state. For both appear to me to be perfectly good refutations; so that at the end of the volume the formal outcome of the triple effort to solve the problem of error and meet the opponent's argument from hallucinations is literally *nil*. $3-1-1-1=0$.

Thus far, then, I do not think it can be said that these vigorous innovators have demonstrated that consciousness does not exist save as an irrelevant relation between objects always and absolutely uncolored by its presence; or that the convenient supposition that some things in consciousness exist solely therein, as "subjective appearances," must be abandoned. But failing a proof of this, the new realism, as a whole, is lacking in logical substructure.

In the interest of a discussion of this main issue, I have been obliged to omit mention hitherto of two carefully reasoned papers which are less closely related to that issue: that of Marvin on "The Emancipation of Metaphysics from Epistemology" and that of Spaulding, "A Defense of Analysis." These both reward the reading irrespective of one's interest, or lack of it, in the new realism. Spaulding's paper contains an effective analysis of some of the confusions of Bergson and other anti-intellectualists.

Professor Fullerton's book also is a defense of "the new realism," but apparently not of the same new realism. We shall soon be obliged to distinguish the various claimants of the name by numerals. Just how Fullerton's view is logically related to that of the authors already discussed, it is a matter of some difficulty to determine. He sometimes seems plainly to reject the relational conception of consciousness and the resultant epistemological monism. "The world," we are told, "is phenomenon; it is in a sense a function of the creature perceiving the world. Each gazes upon his own world." There is "a whole series of phenomenal worlds differing more or less from one another. Only one of these is ours and is known by us directly" (pp. 106–107). There are apparently some things which "should be regarded as existing only in the mind" (p. 129), which are "internal and subjective" (p. 131). Yet we are also told that we are "as directly conscious of external things as we are of anything whatever," and that "we may with a clear conscience accept as external the things we actually perceive, with just the qualities and relations which we perceive them to have" (p. 149). Thus even the secondary qualities are "external" and in no sense subjective (Ch. X.). We do not perceive images of objects, but the objects themselves. Even so qualified a form of the representational theory of perception as Strong's "substitutionalism" is rejected (p. 158). Thus, so far as normal perception is concerned, Fullerton seems first to deny and then to adopt the theory of the immediacy or "immanence" of the real object in perception. The final criterion, however, of any writer's attitude towards the view that consciousness is an external relation lies in his explanation of the facts of error and hallucination. Is the hallucinatory object a function of the perceptual process or is it, too, "external" and independent thereof? Does the long-extinct star "really exist" at the moment when I belatedly perceive it? If not, does not the star actually perceived subsist at the moment in dependence upon the consciousness of that moment? Unfortunately, Fullerton, while he raises these questions, does not meet them in a way which unequivocally de-

fines his attitude to the relational theory. He observes (pp. 156–163) that our errors are largely mere omissions and not creations; that even illusions "deceive no well-informed person"; and that "were men sufficiently well-informed, and were such experiences sufficiently common, there would in no case be the shadow of an illusion," which seems to mean only that if there were no illusions there would be no illusions. The fact remains that illusions, hallucinations and dreams occur; and the question is whether (as some neo-realists hold) the content presented in these can be said to exist in real, objective space, at the time of its presence in consciousness, and whether there is any justification for, or meaning in, calling it "independent" of consciousness. To this question, with which the other new realists so laboriously deal, Fullerton, so far as I can see, gives no entirely plain answer; and it is for this reason that the relation of his realism to theirs remains, at the most significant point of all, obscure. I take it, however, that he does *not* view consciousness as an absolutely functionless relation, and that he would reject the paradox of the objectivity of the illusory.

Assuming this to be his meaning, Fullerton must be understood to regard some content of perception as purely mental, or subjective, and some as wholly objective and independent. The further question remains: Where, and by what criterion, shall we draw the line between the two? Patient and subtle as are Fullerton's reasonings upon this point, I do not find them altogether clear or convincing. His desire, evidently, is to make the realm of the subjective a very little one; hence his exclusion from it even of the secondary qualities, and his apparent reduction of it to the hallucinatory and imaginary merely. But his reasons for drawing the line where he does appear to me blurred through a failure to give and adhere to a single, clear definition of "external" and "objective." In a general way one gathers that (pp. 111–115) things and qualities are external, in the proper sense, when they do not involve a "relation to our sense-organs," when I "can account for them without referring to the relation of my body to them." But this throws little light upon the subject. How am I to know when data which are obviously mediated through my sense-organs involve no relation thereto? When (as in the case of color) specific variations in my sense-organs are uniformly accompanied by specific variations in the qualities which appear in consciousness, are not the latter, in accordance with the definition given, "internal" or mental? But in that case, what becomes of the proof of the externality of color-qualities? Does Fullerton, then, mean that anything is external which without contradiction can be *conceived* as existing without involving the idea of my body? If this is what is meant, one must still object that there are familiar arguments which seem to show that most of the perceived qualities which one object presents to different percipients *are* reciprocally contradictory, so long as the qualities are regarded as inhering independently in the object by itself, and not as functions of its diverse relations to those percipients. These points not being satisfactorily dealt with, Fullerton's realistic construction fails of complete definiteness of outline and consequently of cogency.

A noteworthy part of the book is the interpretation of Kant as the "first great modern realist" (Chaps. V.–VII.); this view is not new, but it has never, perhaps, been so forcibly presented. The most brilliant chapters in the volume are the critical ones. The passages on absolute idealism and on pragmatism are delightfully witty, yet eminently searching, examples of philosophic satire. The latter, I think, is less than just to some aspects of pragmatism; but the former (Chaps. XIII.–XV.) is a masterpiece in its kind.

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Handbuch der Entomologie. Herausgegeben von Professor Dr. Chr. Schröder. Jena, Gustav Fischer. 1913.

For the past twenty years Kolbe's "Einleitung" has been the best known German text-book on entomology. Now Dr. Schröder

(editor of the *Zeitschr. f. wissenschft. Insektenbiologie*) has undertaken to issue a more extensive work. It is significant of the increasing specialization in entomology that this new work is not the product of one author, but of eleven. It is divided into three parts: Volume I. is on the Anatomy, Embryology, Morphology, and Metamorphosis, and is prepared by Dr. C. Börner, Professor P. Deegener, Dr. J. Gross, and Dr. O. Prochnow. Volume II. will treat of the Habits, Distribution, Economic, and Experimental Entomology, and will be written by Dr. Schröder, Dr. K. Eckstein, Dr. O. Heineck, Dr. K. Holdhaus, Dr. L. Reh, and Dr. H. Rübsaamen. Volume III. will consider Paleoentomology, Phylogeny, and Systematics, and is to be prepared by Dr. A. Handlirsch. The portions now issued (three parts of Volume I.) are almost wholly by Dr. Deegener. Chapter I. is on the skin (including color, scales, skin-glands, scent-glands, wax-glands, etc.) with an appendix on the sound organs; Chapter II. treats the nervous system (especially the larger ganglia); Chapter III., the sense-organs, largely histological. In this chapter are various minor errors; the great family Capsidæ is not mentioned under Heteroptera as being without ocelli, the Panorpatæ are stated to have three ocelli, although on a previous page the genus *Boreus* is correctly stated to be without ocelli, and the various cases of ocelli in Coleoptera are unmentioned. The various sense-organs of unknown purpose (pseudocelli, abdominal organs of moths, post-antennal organs) are considered, as well as the supposed correlation or rather complemental development between the eyes and the antennæ. Chapter IV. considers the alimentary canal and its appendages (salivary glands, malpighian glands, anal glands) and is very complete, as Dr. Deegener is particularly interested in this matter. Chapter V. is on the respiratory organs, and is rather one-sided, most attention being given to respiration in aquatic insects and in parasites. Chapter VI. treats of the circulation, blood, heart, the specific heat of insects, fat-bodies, light-organs (rather briefly) and œnocytes. Chapter VII. relates to the endoskeleton and muscles. The muscular system of the imago of *Dystiscus* (as given by Bauer) is taken as typical, with but little comparison to other insects or larvæ. Only a brief summary is given of the endoskeleton, and brief treatment of muscular contraction, attachments of muscles, and muscular power of insects.

The most useful feature of the work is the long bibliographies at the end of each chapter. Although not by any means complete (American references often lacking) these lists furnish references that are difficult to secure but essential to any one studying these subjects. In fact, so useful is this new "Handbuch" that we hope a group of our entomologists will plan an American work on the same general lines.

NATHAN BANKS

TRIALS AND TROPISMS

I

SOME years ago[1] I attempted an analysis of the facts grouped under the familiar but apparently confusing term "tropism theory." In the light of my experience I found myself seriously questioning the validity of a view that had just been published by Jennings in his well-known book, "The Behavior of the Lower Organisms." The issue was essentially this: whether tropisms are developed through selection from overproduced movements by means of the method of trial, or whether they are primary responses in the same sense that these overproduced movements are, and not, therefore, products of a process of selection as suggested.

Jennings soon found opportunity to reply to my objections as well as to those of other critics, notably Loeb and Parker. His reply, however, does not appear to have convinced them, for they have both taken issue since with his conception of the nature of tropic reactions. And though, up to the present, I have not thought it either necessary or desirable to add my own misgivings to a rapidly

[1] "The Method of Trial and the Tropism Hypothesis," SCIENCE, N. S., XXVI., pp. 313–23, September 6, 1907.

growing controversy, I too have failed to be convinced. Controversies fatten on misunderstandings. There is evidence that this one has been no exception to the rule. Some of it may be found in a recent book by Mast[2] and in a review and reply[3] that have since appeared. Accordingly, silence might seem to be the better part. Nevertheless, I am tempted to brave the possibility of further difficulty by accepting what seems to be a reasonable chance of focusing attention more sharply than before on the issue raised in my former paper.

It will be my endeavor, then, to show why the view that tropic reactions are developed through selection of overproduced or trial movements is unsatisfactory. And I shall attempt to do this by calling attention to certain relations between the structure and behavior of non-symmetrical and bilaterally symmetrical organisms that have heretofore met with much scantier consideration than, in my opinion, they deserve. Let me refer first of all to the behavior of the non-symmetrical flagellate *Euglena*.

II

Euglena, as is well known, is a non-symmetrical unicellular organism, with a single non-symmetrically placed photoreceptive region near the gullet, and swims in a spiral path by means of a flagellum, or, in the absence of the latter, assumes a crawling habit that is accompanied by a side-to-side oscillation suggesting the spiral swimming of the flagellated form.

I have been very much impressed by Mast's account of the orientation of the crawling *Euglena* to light. It appears that the organism, crawling in a path perpendicular to a beam of light, on entering the beam executes a turning movement toward the source of light; that this turning movement is accomplished by a series of sharp reactions, defined by a bending of the body away from the source of light; that each reaction follows an abrupt change in intensity of light falling on the photoreceptive region; and that these abrupt changes are connected with the oscillation of the organism from side to side, leading to an intermittent presentation of the photoreceptor to the light in a position effective for stimulation.

Few will deny that constant stimulation plays no obvious rôle here. But many, I am sure, will not fail to be impressed with certain elements of similarity in structure and behavior between *Euglena* and various bilaterally symmetrical organisms with one of a symmetrical pair of eyes blinded. And just here appears a point that has not been always clearly apprehended by the author of "Light and the Behavior of Organisms." Somehow Mast has obtained from my former paper the impression that I evidently consider "that orientation [in *Euglena*] is due to the local effect of unequal stimulation of symmetrically situated points on the body"—and yet do not "explain where the symmetrically located points which are subject to local stimulation are situated in *Euglena*." I have looked carefully over my paper since this statement came to my notice, but have not been able to find any attempt to explain the orientation of *Euglena* on any such basis. That was perhaps a result to be expected, as I had not been conscious of an attempt so to explain the orientation of *Euglena* or any other non-symmetrical organism. Of the symmetrical points to which "it is evident" I refer, I frankly confess my ignorance. Nor do I feel any more hopeful than Mast himself of a successful issue to the most exhaustive search for them. Our reasons for this attitude of mind, however, do not coincide. For mine, the reader is referred to that suggestive resemblance between the structure and behavior of non-symmetrical organisms and symmetrical organisms non-symmetrically stimulated to which I would again call attention.

III

Let us imagine *Euglena* crawling horizontally along a definite axis of locomotion, directly toward a source of light. At successive

[2] "Light and the Behavior of Organisms," New York, 1911.

[3] Parker, *Jour. An. Beh.*, Vol. I., 1911, p. 461; and Mast, *ibid.*, II., p. 209.

moments it comes to lie in different positions, in all of which the single photoreceptor is at the same distance from the axis, and in some of which it occupies positions that—if the forward movement be for the moment disregarded—are symmetrically placed with reference to a plane passing through the axis of locomotion and perpendicular to the substratum. Let us now compare two such symmetrical images of *Euglena* with a bilaterally symmetrical animal, with paired eyes, moving directly toward a source of light. In *Euglena* the single photoreceptor is now on the left, now on the right of the plane of symmetry. In the other organisms, the two photoreceptors are permanently fixed, and one on each side of that plane.

Now *Euglena* swerves toward the light only when it is in such a position that the photoreceptor when on one side of the plane of symmetry receives light at an angle differing from that at which it receives light from the same source when occupying a symmetrical position on the other side of the plane. Just so, according to all varieties of the tropism theory with which I am acquainted, various bilateral organisms swerve toward the light when their eyes, symmetrically placed on either side of the median plane of the body, receive light from a single source at different angles. Expressed in another way, this means that the eyes under such conditions are subjected to different effective light intensities. The very mechanism, then, which has long been held by advocates of the tropism theory to account for the definite, errorless turning movements of bilateral heliotropic organisms toward or away from light, is the mechanism that Mast has shown to be accountable for the heliotropic orientation of the non-symmetrical *Euglena*. If this be the case, it seems evident that, whether or not the separate reactions of *Euglena* whenever its photoreceptor is effectively presented to the light are to be regarded as overproduced movements that may resemble trials, the definitely directive reactions of bilateral animals to light have not been developed by any process of selection based on such movements.

IV

It remains to consider the possibilities of such a mechanism for producing the delicately accurate heliotropic adjustments of some organisms; as well as the relation between pronounced shock reactions with no obvious relation to the direction of locomotion, and the definite errorless turning movements ordinarily referred to as tropic reactions.

Mast[4] says of the orientation of *Euglena* in light from two sources:

> When the light from the two glowers was equal and the *Euglenæ* positive, they moved in a general way toward a point midway between the glowers. But when it was unequal, they moved toward a point nearer the source from which the more intense light came. . . . This experiment is particularly striking if the glower on the track is gradually moved from a position in which the light intensity from it is much lower than that from the stationary glower to a position in which it is much higher. Under such conditions one can clearly see these organisms, especially the free swimming forms, gradually change their direction of motion through an angle of nearly 90°.

I gather from this description that changes in intensity are followed by reactions that vary with the degree of change. If this be true it may well account for the very slight variations which bilaterally symmetrical heliotropic organisms make from a straight course toward a source of light, and the precision with which such variations are corrected.

Further evidence of this sort is obtained from Fig. 13, p. 96, where, if the reactions are to be considered accurate in detail as drawn, it is seen that the orienting contractions of *Euglena* vary in magnitude as the path of the organism inclines more and more toward the source of light.

Similarly, Jennings[5] describes the avoiding reaction of the free swimming *Euglena* in the following terms:

> The *Euglenæ* are swimming about at random in a diffuse light, when a stronger light is allowed to fall upon them from one side. Thereupon the for-

[4] "Light and the Behavior of the Lower Organisms," p. 86.

[5] "Behavior of the Lower Organisms," p. 138.

ward movement becomes slower and the *Euglenæ* begin to swerve farther than usual toward the dorsal side. Thus the spiral path becomes wider and the anterior end swings about in a larger circle and is pointed successively in many different directions. In some part of its swinging in a circle the anterior end of course becomes directed more nearly toward the light; thereupon the amount of swinging decreases, so that the *Euglena* tends to retain a certain position so reached. In other parts of the swinging in a circle the anterior end becomes less exposed to the light; thereupon the swaying increases, so that the organism does not retain this position but swings to another. The result is that in its spiral course it successively swerves strongly toward the source of light, then slightly away from it, until by a continuation of this process the anterior end is directed toward the light. In this position it swims forward.

Figs. 91 and 92, p. 135, show variations in the severity of the reaction, the second figure representing but a very slight widening of the narrow spiral in which the organism has been swimming. Fig. 93, p. 139, represents the path of a *Euglena* executing a turn of 180° by a series of similar slight widenings of the spiral.

From such evidence it would seem that the motor reflexes of *Euglena* appear in varying degrees that shade more or less gradually into each other as the strength of stimulation varies. This admirably meets the requirements of a "tropism theory" that is expected to account for the gradual but definite and errorless turning movements executed by so many bilaterally symmetrical organisms in orienting themselves with respect to a source of light.

These considerations inclined me to the view that in bilaterally symmetrical organisms the shock reactions that have no obvious connection with orientation to a stimulus and are produced by *sudden changes in intensity* of light may occupy one end of a series at the other end of which are the very small reactions by means of which the tropic turning movement is achieved. In that case the difference in effect on orientation of these extreme cases would not indicate any fundamental difference in mechanisms governing them, but rather a pronounced difference in the magnitude of the responses to stimuli of different intensities.

Recently, however, my attention has been called to new evidence, shortly to be published by my friend, Dr. F. W. Bancroft, that in *Euglena* the mechanisms of the shock reaction and the tropic reaction are distinct. How general this observation may prove to be is not now certain. But in any case, the shock reaction can hardly be said to occupy the position of a prototype from which trialless heliotropic turning movements have been derived by any process of selection.

Harry Beal Torrey

Reed College,
Portland, Oregon,
January 9, 1913

AN AID TO STUDENTS

The Academy of Natural Sciences of Philadelphia has published, as part of the aftermath of the brilliant centenary celebration of last year, an index to its publications from the first volume of the *Journal* issued in 1817 to the conclusion of the sixty-second volume of the *Proceedings* completed in 1911, making a total of eighty-three volumes. The portly index comprises 1,433 octavo pages and is divided into two sections. The first contains the titles of all the contributions to the series, arranged alphabetically under the names of the authors, and ranges from brief paragraph reports of the communications made verbally before the meetings of the academy to the classic quarto volume by Joseph Leidy on the extinct mammalian fauna of Dakota and Nebraska, and the beautiful monographs on the burial mounds of the south by Clarence B. Moore.

The second section is composed of an alphabetical arrangement, from *aalensis* to *Zythia*, of the names of every species, genus, and family described or referred to in the several volumes. It is estimated that there are about 124,600 such entries in the list and some idea of the labor involved in its preparation and arrangement may be had from the fact that the original entries under the letter P numbered 19,500, under S 16,650 and under T 10,300.

These were, of course, condensed in the arrangement, all the page references to a given name being placed under a single entry so that the printed result is much curtailed.

During the first five years of the academy's life it maintained a sort of chrysalis existence without much communication with the outside world. Of the six men who attended the initial meeting but one, the Dutchman Gerard Troost, later elected the first president, had any scientific training. At the next meeting Thomas Say was "adopted" by the others as one of the founders and he has since been regarded as one of the seven to whom the academy owes its existence. The communications to the meetings were at first confined almost solely to selections from Rees's Encyclopedia and certain text-books of science, but original observations soon became more frequent and by 1817 a sufficient amount of such material was in possession of the society to warrant the belief that an avenue of publication would be desirable. Through the interest and zeal of William Maclure, a Scotch philanthropist, the first number of the *Journal* was placed before the meeting held May 20, 1817. The volume contained contributions from Chas. A. Lesueur, Geo. Ord, Thomas Say, Thomas Nuttall, and William Maclure. Its interest and value were much enhanced by the beautiful engravings by Lesueur. It was at the time the only avenue of communication with the scientific world possessed by the working naturalists of America.

This series staggered on with intervals of quiescence until 1842, when it was decided that the *Proceedings*, which had been begun the previous year for the purpose of giving prompter publicity to the current business of the academy, supplied all that could be secured by an octavo publication.

To provide for papers requiring more elaborate illustrations than could be supplied in the octavo form, a quarto journal was started in 1847 and has been continued to the present time, the superb fifteenth volume having been published last December as the chief memento of the celebration held in March. Incidentally it may be mentioned that the prompt issue of that volume, within nine months of the event it records, has been regarded all over the world as a record-breaking achievement. The illustrations to the quarto series were from the first of a high order of artistic merit. Special mention may be made of the colored illustrations of Cassin's birds, supplied by the liberality of Thomas B. Wilson; the really beautiful lithographs by Ibbotson of Isaac Lea's Melanians and Unios; and more recently the superb chromoplates of prehistoric pottery furnished by Mr. Clarence B. Moore in illustration of his monographs.

Access to the scientific contents of the eighty-three volumes, constituting one of the most important agencies in the advancement of science, will be greatly facilitated by the issue of the index which will undoubtedly be highly valued by students.

A few pages are devoted to a record of the time of publication of the several parts and volumes. The minutes, correspondence, and accessions lists of the academy were consulted to determine as many such dates as possible, and it is to be regretted that the result is not complete, the requisite data not being at hand, after the most careful search, to make it so. As far as the record goes, however, it will establish dates of publication of many researches of the first importance and help to determine many questions of priority, a matter to which the working naturalist is apt to attach much more importance than do those who value results without caring greatly as to who attains them.

EDW. J. NOLAN

SPECIAL ARTICLES

FACTORS INFLUENCING THE SURVIVAL OF BACTERIA AT TEMPERATURES IN THE VICINITY OF THE FREEZING POINT OF WATER[1]

IT has been held by some bacteriologists that, while temperatures about the freezing point of water are less destructive of bacterial life than those about the boiling point, low temperatures are not only unfavorable to the growth and multiplication of bacteria, but

[1] Preliminary communication.

also to their prolonged existence. Prudden's experiments (1887) with water suspensions of a staphylococcus, in tubes greased to prevent crystallization at the temperatures employed (15–25° F.), led him to believe that at the same temperature the destruction of bacteria, due to cold, was greater when the water did not freeze, than when it did. Park, however, made similar experiments (1900) with *B. typhosus* and found that at the same temperature the reduction was 30 per cent. less in water remaining liquid for three days than where the water was frozen for the same length of time. Park further cites an experiment upon the freezing of typhoid bacilli in which 50 per cent. to 70 per cent. are killed "at the time," not more than 10 per cent. surviving after one week and 1 per cent. after four weeks, while Sedgwick and Winslow, after a careful review of the literature and many experiments, came to the conclusion that there is "during the first half hour of freezing a heavy reduction . . . amounting to perhaps 50 per cent. After this brief period of sudden but uncertain 'reduction' the destruction of the germs proceeds pretty regularly as a function of the time." Prescott and Winslow in their "Water Bacteriology" remark (p. 17) that "Temperature has a direct relation to bacterial life, and the number of parasitic bacteria at least may be quickly lessened by the action of cold." These conclusions are supported by the fact that ice, and especially old ice, even when formed from polluted sources, is very low in bacterial life.

On the other hand, it has gradually become known that various frozen foods, such as ice cream, frozen meat and frozen milk, often contain very large numbers of living bacteria, and this, too, even when kept for a long time, so that a serious contradiction seems here to exist between theory and fact. To this contradiction my attention was first drawn some two years ago during bacteriological studies of frozen eggs, and especially by the fact that such eggs, even after an exposure of many months to a temperature of 0° F., still contained millions of living bacteria. Obviously it was no longer possible to hold that either mere cold or time is in and of itself necessarily destructive of bacterial life; and in the hope of bringing theory more clearly into harmony with experience I have within the last year made numerous experiments calculated to throw further light upon the general behavior of bacteria at temperatures about the freezing point of water.

Thus far I have worked almost exclusively with a single species, *B. coli*, which, as is well known, thrives at various moderate temperatures and especially at the blood heat. I have employed chiefly a 24-hour agar growth suspended in water, in physiological salt solution, in various dilutions of fat-free milk, in various mixtures of pure glycerine and water, and in solutions of cane sugar and of commercial glucose. In some cases freezing was done directly in test tubes; in other cases in an ice cream freezer with the formation of an ice "mush" or magma. By the courtesy of the Quincy Market Cold Storage and Warehouse Company of Boston I have been able to hold the suspensions thus frozen at temperatures as low as zero F. for periods of from four to eight months. The experiments are still in progress and some of them may be extended over a term of years.

The following is a brief summary of results:

I. When *B. coli* are frozen in Boston tap water (in test tubes) as solid ice, and held at —20° C., only a fraction of one per cent. of the original number remain alive at the end of five days. Storage of a few weeks results in complete destruction of the bacteria. These results confirm those of Sedgwick and Winslow.

II. When *B. coli* are frozen in Boston tap water not solidly, but as a water ice or sherbet is frozen, and held in this condition at —20° C., a large percentage remain alive for many months.

III. When *B. coli* are frozen in milk, pure and diluted to various degrees with water, the death rate of *B. coli* increases with the dilution, the largest numbers surviving in the un-

diluted milk and the fewest in that containing the most water.

IV. When suspended in aqueous mixtures containing from 5 per cent. to 42 per cent. of chemically pure glycerin and held at —20° C., a very large percentage of *B. coli* remain alive for at least six months.

V. At +37° C., *B. coli* in water or in 5 per cent. to 20 per cent. glycerin[2] die rapidly, few if any remaining alive at the end of 72 hours. The death rate diminishes as the holding temperature is lowered, though it is still marked even just above 0° C.; but at a temperature slightly lower a sudden change appears, the death rate at and below that point being but little, if any, greater than at —20° C.

VI. By covering a 24-hour growth on agar with a sterile 10 per cent. cane sugar solution, and holding at —10° C., stock cultures of *B. subtilis, B. aurococcus, B. megaterium, B. fluorescens, B. proteus* and *Sarcina aurantiacus* have been kept in a vigorous condition (without transferring) for eight months.

From these results the following conclusions may be drawn:

Low temperatures alone do not destroy bacteria. On the contrary, they appear to favor bacterial longevity doubtless by diminishing destructive metabolism. Frozen food materials, such as ice cream, milk and egg substance, favor the existence of bacteria at low temperatures, not because they are foods, but apparently because they furnish physical conditions somehow protective of the bacteria.

It seems likely that water-bearing food materials as well as sugar solutions, glycerin solutions, etc., freeze in such a way that most of the bacteria present are extruded from the water crystals with other non-aqueous matters (including air) and lie in or among these matters without being crushed or otherwise injured; while in more purely watery suspensions, and, above all, in water itself in which the whole mass becomes solidly crystalline, they have no similar refuge but are perhaps caught and ultimately mechanically destroyed between the growing crystals. This theory would explain the absence of live bacteria in clear ice, their comparative abundance in "snow" ice and "bubbly" ice, and also the fact that the more watery food materials when frozen contain the fewest, and the least watery the most, living bacteria.

The comparatively rapid death of bacteria in non-nutrient materials at higher temperatures and their slower dying at lower temperatures agrees well with the theory of simple starvation or destructive metabolism. At the higher temperatures they perish quickly because they burn themselves out quickly; at the lower, more slowly, because they consume themselves more slowly. At temperatures where metabolism ceases altogether they continue to exist in a state of suspended vitality similar to that exhibited by many other and higher plants which in the far north are subjected without apparent injury for long periods to temperatures much below the freezing point of water.

S. C. KEITH, JR.
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

[2] Glycerine mixtures much exceeding 20 per cent., at temperatures above the freezing point of water, act as mild antiseptics. Under 20 per cent. this is not the case, the death of the bacteria apparently resulting from lack of food, as it does not occur when a small amount of peptone is present.

HEMOPHORIC FUNCTION OF THE THORACIC DUCT IN THE CHICK

IN a recent investigation of the development of the thoracic duct in the common fowl, the writer studied also certain aggregations of mesodermal cells correlated with the developing duct, and considered by Sala,[1] more than ten years ago, as "cords" of mesenchymal cells out of which were "hollowed" the rudiments of the duct.

The writer believes, and in the near future will publish evidence to substantiate the belief, that these aggregations of mesodermal (mesenchymal) cells comprise developing blood cells which are differentiated *in situ* out of the indifferent mesenchymal syncytium, that these blood cells then gain access to the lymph

[1] Sala, *Richerche fatta nel Lab. di Anat, Norm. della R. Univ. di Roma,* Vol. 7, 1900.

channels making up the developing thoracic duct, and that finally the hemal cellular elements in question reach the blood stream *via* the thoracic duct and jugular lymph sac. Considering the vast number of blood cells, especially erythrocytes, arising in this region and the probability that they are conveyed to the general circulation by the thoracic duct, this duct assumes, therefore, an additional phase of importance in the chick in that it performs a hemophoric, or blood-carrying, function.

The view that the thoracic duct may arise as detached portions of veins is in the case of the chick quite untenable, since the tissue in which the lymph spaces and channels arise remains notably non-vascular up to the time the first lymphatics appear. The writer believes he has sufficient evidence, soon to be published, to show that the lymphatics arise as isolated lacunæ directly from mesenchymal intercellular spaces, are not in any sense derived from veins, and subsequently coalesce to form the continuous channels of the thoracic duct.

The point recently made by other investigators,[2] namely, that the superficial lymph plexus in the region of the posterior lymph heart in the chick contains stagnant blood which has backed up into it from the veins, is invalid in the case of the thoracic and its blood content because there are no veins in this region from which "backing up" could occur.

Adam M. Miller

A POSSIBLE MEANS OF IDENTIFYING THE SEX OF (+) AND (—) RACES IN THE MUCORS

It has been shown by the writer (1) that the majority of the forms among the mucors are diœcious, with the sexes separated in male and female races which are capable of being propagated apparently to an indefinite number of vegetative generations by means of nonsexual spores formed in sporangia. In all the diœcious species carefully investigated the opposite gametes, which are produced and unite to form zygospores when the two sexual races of a given form are grown together, do not appear to differ morphologically. Lacking a definite criterion which an inequality of the gametes would have afforded, the writer has provisionally designated the opposite sexes in these forms by the signs (+) and (—) on account of a generally greater vegetative[1] luxuriance of one sex over the other. That in reality the two sexes are represented in the (+) and (—) groups is shown by the sexual reaction which may occur not only when the (+) and (—) races of the same species are grown together and perfect zygospores are produced, but also by the sexual reaction which may occur when (+) and (—) races belonging to different species are grown together. This reaction between the opposite races of different species has been called imperfect hybridization since it does not lead to the formation of perfect hybrid zygospores, but usually stops short with the formation of progamates, though occasionally gametes are produced which, however, never unite.

A sexual race of a diœcious species if grown between the (+) and (—) races of another test species used as a standard, will show a line of sexual reactions on one side only. Some of the hermaphroditic species, on the other hand, when similarly grown, show a response to both (+) and (—) test races and produce therefore 2 lines of sexual reactions.

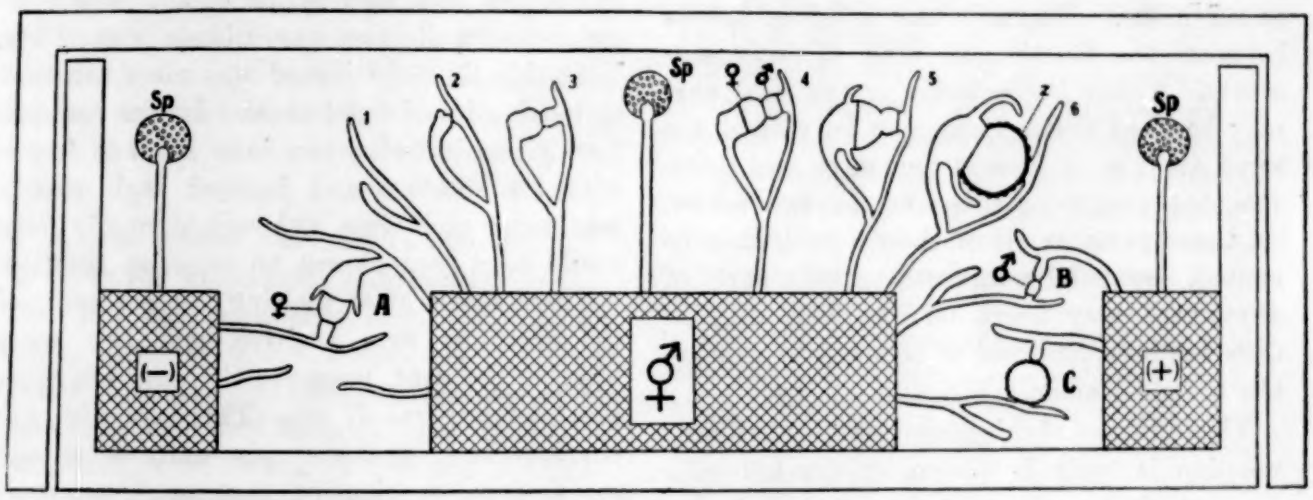
Some few species in the hermaphroditic group are distinctly heterogamic with a constant difference in size between the conjugating gametes. Figs. 1–6 in the accompanying diagram will illustrate the process of conjugation in such forms. It seems reasonable to consider the larger gamete female and the smaller male. Upon this basis, if a sexual reaction could be established between these unequal gametes and the (+) and (—) races, the race reacting with the larger female gamete must be considered male, while the race reacting with the smaller male gamete must be considered female.

[1] "Zygospore Formation a Sexual Process," Science, N. S., 19: 864–866, 1904; "Sexual Reproduction in the Mucorineæ," *Proc. Am. Acad.*, 40: 205–319, pls. 1–4, 1904.

[2] Clark, E. L., *Anat. Record*, Vol. 6, No. 6, 1912; Clark, E. R., *Anat. Record*, Vol. 6, No. 6, 1912.

The difficulties in technique involved in following the sexual reactions in a thicket of filaments have been overcome by growing the heterogamic hermaphrodite (♂) in a Petri dish between the (+) and (—) test strains and cutting channels in the nutrient agar between the different growths. If the Petri dish be then inverted, the growth of the reacting filaments may be followed in mid air in the channels.

Only a single heterogamic species has been found which will give reactions with both (+) and (—) races and only a single diœcious species which will react with both male and female gametes of this heterogamic hermaphrodite. These have accordingly been used in making the tests shown in the accompanying diagram.



SEXUAL REACTION BETWEEN A HERMAPHRODITIC MUCOR AND (+) AND (—) RACES OF A DIŒCIOUS SPECIES

Diagrammatic representation of a Petri dish culture showing a heterogamic hermaphroditic mucor (♂) in the center separated by channels on either side from the (+) and (—) races, respectively, of a diœcious species.

Sp., Sporangia containing spores by means of which the plant may be reproduced nonsexually.
1–6, stages in development of a hermaphroditic zygospore from unequal ♂ and ♀ gametes.
A, sexual reaction between a (—) filament and ♀ gamete.
B, sexual reaction between a (+) filament and ♂ gamete.
C, a ♂ azygospore formed at stimulus of contact with a (+) filament.

In the left hand channel at *A* in the diagram, a filament from the (—) race is shown giving a sexual reaction with the larger ♀ gamete of the hermaphrodite, while in the right-hand channel at *B* a filament of the (+) race is figured, showing a sexual reaction with the smaller ♂ gamete of the hermaphrodite. The male gamete, which has been cut off from a filament of the hermaphrodite at the stimulus of contact with a (+) hypha, frequently surrounds itself with a thick wall and assumes the appearance of a resting azygospore, as is shown at *C*.

Of three other heterogamic hermaphrodites investigated, two show a sexual reaction with the (+) race only and one with the (—) race only. It is difficult to interpret the sexual reaction when shown with only one of the two sexual races.

Judging from the behavior of the forms figured in the diagram one would seem justified in considering the vegetatively more vigorous (+) race as female and the less vigorous (—) race as male.

The details upon which the conclusions in the present article are based are being published in another journal. The article itself is a summary of a paper presented before the Botanical Society of America, January 2, 1913.

A. F. BLAKESLEE

THE EFFECT OF MOLTING ON RHEOTAXIS IN ISOPODS

In an earlier paper[1] I showed that the strength of a current in which stream isopods can maintain themselves is determined by the period of weakened responses during the breeding season. More recent studies have shown that the shorter but more frequently recurring molting period is also of importance in this respect.

The molt in the isopod, *Asellus communis* Say, usually occurs at intervals of from 13 to 25 days, although over 70 days may elapse between molts. Normally the covering breaks between the fourth and fifth thoracic segments. Either the anterior or posterior part may be shed first. Both may be molted the same night or as long as four days may intervene between the molting of the two halves. At times parts or all of the covering may be molted, segment by segment, or even parts of a segment may break off; as long as nine days has been observed to be spent in molting the abdomen alone.

The influence of this period on the rheotactic reaction is typically shown by the following account of the responses of an isopod during one molting period. The isopod under observation was a male, 12 mm. long, which averaged normally 86 per cent. positive rheotactic reactions. The molt began just after a test of 11 trials which averaged 35 per cent. positive, 35 per cent. negative and 30 per cent. indefinite. During each minute's reaction the isopod moved an average distance of 40 centimeters.

The covering broke between the fourth and fifth thoracic segments and the forward part was worked off over the head by a series of undulating motions of the body and by movements of all the legs. It took 70 seconds to complete the process. One of the antennæ that had been dragging before the molt occurred was dropped off with the exuvia. Immediately after the molt the forelegs were smaller than usual.

During the process the isopod stayed in one place and disregarded all currents. A current set up immediately after the molt was completed was also disregarded. After about two minutes in the same place the isopod moved across the pan and stopped in an angle 17 cm. away. It rested there quietly for seventeen minutes, when it was again tested for rheotactic reaction. No movement occurred. At thirty minutes after molting 10 trials showed 30 per cent. positive, 60 per cent. indefinite and 10 per cent. no reaction at all. The average reaction distance per minute was 38 cm.

At this time the isopod was more sensitive to touch stimuli than usual. In the response just given it twice ran into another isopod with its antennæ and jumped back over a centimeter each time, although normally there would have been almost no negative reaction.

Three hours after molting, 70 per cent. of the reactions were positive, and two hours later 90 per cent. were positive and the reaction distance was 47 cm. This last trial was characterized by the steady movements and rapid, definite orienting that mark the normal response of stream isopods.

In this case the molt of the posterior part occurred two days later, after nine P.M. At nine the response was: 40 per cent. positive, 40 per cent. negative and 20 per cent. indefinite. The next morning 80 per cent. of the responses were positive and the other 20 per cent. were negative. The reaction distance was only slightly greater in the morning readings. On the morning after the next molt 31 days later, this isopod would start positive and turn negative as though the current pressure against the more sensitive covering was painful.

An isopod stands higher from the bottom when nearing molting time, which is probably due to the increasing stiffness of its legs. At this time the posterior legs appear harder to move and may become tangled, thus throwing the isopod as it tries to crawl. Immediately after the molt it is more easily swept off its

[1] Allee, W. C., 1912, "An Experimental Analysis of the Relation between Physiological States and Rheotaxis in Isopoda," *Jour. Exp. Zool.*, Vol. 13, pp. 269–344.

feet than during other parts of the molting cycle.

The more gradual molts may also affect the rheotactic reaction. A cut of 20 per cent. in the positive response has been observed when one segment was molted. Regulation from depressed to normal positiveness occurs more rapidly after a molt than at any other time.

The detailed account just given shows that the effect of the molting period lasted for about five hours after the actual ecdysis took place. If the period extended as long beforehand it would make the time during which the rheotactic response is affected by the molting process extend over a period of ten hours. Since both the rheotactic and thigmotactic responses are weakened, this must be a critical time in the life of the stream isopod.

W. C. ALLEE

A NEVADA RECORD FOR THE CANADA OTTER, LUTRA CANADENSIS (SCHREBER)

No otter has apparently been known from Nevada, although *Lutra canadensis* is known to occur in Idaho, and the type specimen of *L. canadensis sonora* (Rhoads) was taken at Montezuma Well, Yavapai County, Arizona. The Walker-Newcomb Expedition of the University of Michigan, in the summer of 1912, found a species common on the Humboldt River in the vicinity of Elko and Carlin, in the northeastern part of the state, and from a trapper a specimen was secured for the Museum of Zoology (Cat. No. 44,419).

The specimen obtained, a large adult male, is evidently to be referred to *L. canadensis*, as at present defined. The coloration is not as pale as described for *L. c. sonora*, being dark liver-brown above and paler below, the cheeks, lips, chin and throat whitish; and the postorbital processes are not attenuated, as in *L. c. sonora*, but short and stout, as in typical *L. canadensis*.

ALEXANDER G. RUTHVEN,
FREDERICK M. GAIGE

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE eighty-seventh regular meeting of the Botanical Society of Washington was held at the Hotel Cochran, February 25, 1913. This was the regular annual opening meeting of the society. Fifty members and forty-two guests were present.

The retiring president, Mr. W. A. Orton, delivered an address entitled "Environmental Influences in the Pathology of *Solanum tuberosum*." This paper was published in the *Journal of the Washington Academy of Sciences* (Vol. 3, p. 180, April 4, 1913).

The eighty-eighth regular meeting was held in Assembly Hall, Cosmos Club, Tuesday evening, April 1, 1913.

Mr. James T. Jardine was elected to membership.

The following papers were presented:

Notes on Diseases of Trees caused by Mistletoes: Dr. G. G. HEDGCOCK.

Mistletoes are found only on conifers in northern and northeastern United States; only on angiosperms in southeastern and southern portions; and on both in western and southwestern regions, where they are the most widely disseminated.

The rate of spread of mistletoes is without doubt very slow. Near Frazer, Colorado, on an old burn in the forest, the rate of spread of *Razoumofskya americana* (Nutt.) Kuntze on the lodge pole pines (*Pinus contorta* Lond.) is estimated to be from 6 to 12 feet per annum, where mechanical expulsion of the seeds aided by winds are the controlling factors. Sporadic infections at much greater distances are caused possibly by birds or animals.

Light is the most important factor in determining the spread of mistletoes of species of both *Razoumofskya* and *Phoradendron*. Trees in the open, and in more exposed conditions, whether on ridges or edges of canyons or on level areas are most subject to attacks by mistletoes of both genera on account of the abundance of light. Trees in dense forests are not subject to attack. Mistletoes are stunted by dense shade, and bear but few, if any seeds, and can not well maintain themselves under conditions where the light is deficient.

One of the immediate effects of the presence of the sinkers of these parasites in the tissues of host trees and shrubs is a tendency to hypertrophy in the immediate region of penetration. In case of species of *Phoradendron*, unless the mistletoe plant is broken off there is little or no tendency for its sinkers to spread laterally in the tissues of the host, and when broken off, the rate of spread is slow, and no witches brooms are formed. In case of species of *Razoumofskya*, witches brooms are commonly produced. The lateral sinkers in such cases spread in the soft tissues of the host, keeping

pace with each year's growth, and sending forth new aerial shoots, from time to time. The stimulus of the presence of this ramifying network of the sinkers of the parasite causes an increase in the number of buds and twigs produced by the limb of the host attached and results in the formation of a more or less dense witches broom. The ability of the mistletoe to grow out to the extremities of the limbs enables it to send out shoots in the best illuminated portion of the broom, and bear seeds under the most favorable conditions of light.

All species of mistletoe are considered injurious in their final effect upon their host trees and shrubs. The leafy *Phoradendrons* are no doubt less injurious, owing to their increased chlorophyll-bearing surface and consequent greater ability to manufacture hydrocarbons. The leafless species of *Phoradendron* are more injurious than leafy ones. Species of *Razoumofskya,* owing to a very greatly reduced chlorophyll-bearing surface, are the most injurious of all. All species stunt the growth of the hosts. Owing to the slow spread of species of mistletoe in the forest, if all diseased trees are cut down on areas where timber sales are conducted, it will be possible to greatly lessen, if not entirely shut out these parasites from our future forests.

Notes on the Botany of Trinidad: Professor A. S. Hitchcock.

Mr. Hitchcock remained on the island of Trinidad from November 25 until December 31, except a few days spent on Tobago. On Trinidad there were collected 350 numbers of grasses, representing about 175 species. Grisebach (Fl. Brit. W. Ind.) describes 87 species from the island and Hart (Herb. List, Bot. Dept. Trinidad) lists 112 species. Several species known to grow in Trinidad were not obtained by Mr. Hitchcock, but many species were added to the known flora. Among the more interesting regions of the island were the Pitch Lake, where several species of grasses were found that were observed nowhere else, including *Panicum chloroticum* growing only in the water-holding depressions of the pitch; Aripo and Piarco Savannas, isolated low flat grassy openings in the valley of the Caroni River, where were found a probably new species of *Raddia* and *Paspalum serpentinum* Hochst. not found since the original collection by Keppler in Surinam nearly a century ago, and two new species of *Panicum;* and St. Joseph Savanna on the mountain side near the ancient capital of the island, St. Joseph. This savanna is of especial interest because the mountain sides are generally covered with forest except where cleared for cultivation. This savanna has occupied its present position since an indefinitely early period, as shown by the flora. The dominant grass is *Trachypogon plumosus,* a species which has not been reported from Trinidad. This species together with others of the association are the common constituents of the savannas found on the Pacific slope of Panama and Central America. In this savanna was found an undescribed species of *Axonopus,* a beautiful golden annual, allied to *A. aureus.* At Tabaquite in the center of the island in the original forest or "High woods" was found another undescribed species of *Raddia* and the rare *Pharus parvifolius* Nash. Several other apparently undescribed species were found on various parts of the island. Most of the species, whose types were from Trinidad, were recollected at their type localities. The results of the expedition to Trinidad and to Jamaica, visited earlier on the same trip, were very satisfactory and will supplement the large West Indian collections previously incorporated in the National Herbarium.

C. L. Shear,
Corresponding Secretary

The Anthropological Society of Washington

The 468th regular and 34th annual meeting of the Anthropological Society of Washington was held in room 43 of the new building of the National Museum at 4:30 P.M., April 15, 1913, the president, Mr. Stetson, in the chair.

The minutes of the last preceding annual meeting were read and approved.

Obituary notices were presented as follows: Miss Alice Fletcher for Miss Sarah A. Scull; Mr. F. W. Hodge for Mr. W J McGee; Dr. Lamb for Dr. Robert Fletcher.

The following officers were elected and installed for the ensuing year:

President—Mr. George R. Stetson.
Vice-president—Dr. John R. Swanton.
Secretary—Dr. Daniel Folkmar.
Treasurer—Mr. J. N. B. Hewitt.
Councillors—Mr. George C. Maynard, Mr. Felix Neumann, Dr. I. M. Casanowicz, Dr. E. L. Morgan and Mr. Francis LaFlesche.

Invitations to meetings of the National Academy of Sciences and the German Anthropological Association were presented and accepted with thanks.

Wm. H. Babcock,
Secretary